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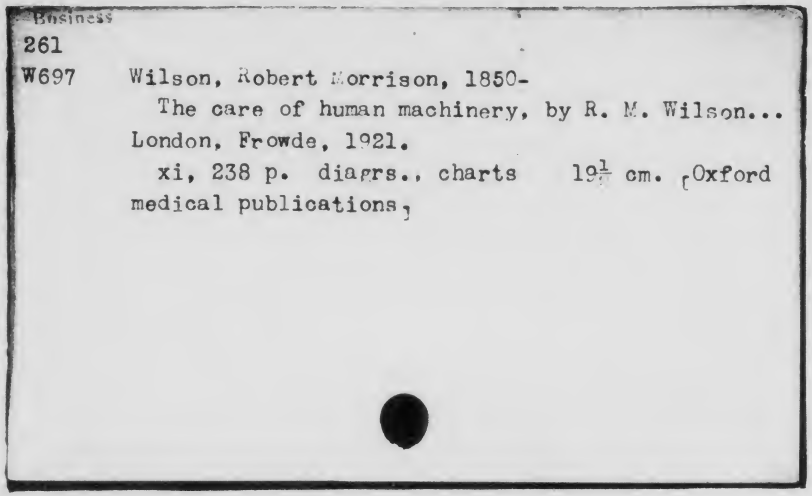
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THE CARE OF HUMAN MACHINERY

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TO

MR. T. S. SHELDRAKE

IN TOKEN OF ESTEEM AND ADMIRATION

PREFACE

INDUSTRIAL Medicine is a science in its babyhood. It is a lusty baby. Already the doctor appears as the friend of employer and employed, showing how these may reconcile their differences in the light of scientific facts. The object of all industry is output. This can be secured in full measure only by healthy, happy, "human machinery." So that the good employer is also the prosperous employer, the healthy employee also the good one. Here is a new basis for the settlement of industrial disputes.

In the following chapters the elements of the subject are set forth in language as simple as possible, since the volume is intended not only for medical men, but also for employers of labour and their workers. The writer desires to thank *The Times Publishing Company* for permission to reproduce material appearing in their *Trade Supplement*, and to the Editor of that Journal he tenders his warmest regards. That Industrial Medicine has made the

rapid strides achieved by it in this last year is due, in no small measure, to the foresight and encouragement of the Editor of the *Times Trade Supplement*, who early recognized the meaning of the new movement, and who lent to it all the weight of his great authority and influence.

R. M. WILSON.

London, *December* 1920.

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CHAPTER I

INDUSTRIAL FATIGUE

THE problem which faces every employer of labour to-day is how to maintain or increase his output and at the same time fulfil or improve upon the requirements of the law with regard to the wages, times of work, and general treatment of his employees. His fear is, as each fresh demand for shorter hours of labour is made—no reduction of wage being contemplated in connexion with the demand—that, if it be acceded to, his margin of profit must shrink. Consequently he is apt to adopt an uncompromising attitude and to tell his employees that if they persist in their claims he will be forced to shut down altogether.

This standpoint is comprehensible, but it does not follow that it is reasonable. It may, on the contrary, be unreasonable when modern scientific work on hours of labour and fatigue is taken into account. It may even be suicidal, for just lately science has cast some strange light upon the darker places of industry.

When the munition factories were established it

was decided to set up in connexion with them a committee of expert men of science to carry out research into industrial efficiency from the point of view of the employer and the employed. The first subject which this committee investigated was "fatigue"; and the results obtained were of a remarkable character. Let us put the matter broadly in a simple illustration.

A group of *five* male voluntary workers were able in a certain factory in eight hours (or seven hours free of meals) to exceed the average day's output of *eight* men, who worked fourteen hours (or twelve and a half hours free of meals). Though it was admitted that the five men worked at a "sprint" and could not, probably, have maintained this daily, nevertheless it was proved that on four days a week they could easily repeat their performance.

The startling result emerged that these men could do in four days rather more than the whole week's work of an equal set of men adopting the other system of hours. Moreover, they could, while exceeding the output of the every-day-and-all-day group, enjoy longer nights, have more recreation in each working day, and have three whole holidays in each week.

The conclusion was drawn that "the paid week-day workers at this factory who have been working their long hours for many months might have greatly improved both their output and their comfort under a better-chosen system of special efforts alternating with suitable rests." The work in

question was work of a uniform "repetitive" kind involving moderate physical exercise.

In another factory a fact no less striking was elicited quite by accident. The factory was an old-established one, to which it was proposed to add a new shop of a size sufficient to produce 5000 articles per week—this estimate of capacity for output being based on the whole experience of the business. New hands were engaged for the new shop. They were somewhat inexperienced. Yet, to the amazement of every one, after six months, while the experienced hands in the old shops were producing 5000 articles per week, the inexperienced hands in the new shop produced 13,000 articles per week. All the mechanical conditions of work were identical, not only in this factory, but also in other similar factories, yet nowhere did older hands approach this output of the new men. The comment was made by the scientists who investigated the case, "the lower output by the more experienced hands appears to be assignable only to the effects of long-standing customary restrictions upon habits or rhythm of work from which the newer hands are free." In other words, fatigue crept in in the one case, while it did not creep in so soon in the other.

Fatigue, then, is a matter of great economic importance, and a knowledge of its nature, causes, and the means of avoiding it has become vital to every enlightened employer at the present moment. For work done while fatigue is present is inferior work, wasteful work. The employer is paying full

wages for it and he is obtaining less than value for his money.

Fatigue, indeed, is indicated by a diminished capacity for doing work. This is the real economic meaning of the state, and any other definition should be ruthlessly excluded by those who are considering it from the business point of view. Moreover, the bodily sensations which are commonly associated in the public mind with fatigue are misleading. These bodily sensations are a late manifestation, and fatigue—that is, industrial inefficiency—may be present and may be developed to a high degree without there being any bodily manifestation of "tiredness" at all. In other words, the man may appear to be, and may feel, quite fresh; yet, as judged by his capacity for output, he may be suffering from industrial fatigue of a marked character. His employer is thus wasting his money; he is paying for that which he cannot possibly receive.

The reason for this distinction between what the layman calls fatigue and what the modern employer in his own interest should recognize as that state is to be found in the nature of the bodily mechanism whereby work is accomplished. We make no excuse, therefore, for giving an outline of this mechanism.

The performance of work depends on several factors—the senses and the nerves which connect these with the brain, the brain itself, the nerves which carry the messages of the brain to the muscles, and finally the muscles. The popular idea of fatigue as "tired muscles" is altogether too restricted.

The muscles may not be tired at all (they very seldom are), and yet the nervous system which controls them may be exhausted to such a degree that working capacity is reduced far below normal. Indeed, so far as industrial fatigue is concerned, the seat of action is rather on the nervous than on the muscular side. The fatigued worker is in some ways comparable to a motor engine running with a choked exhaust pipe. There is plenty of power, but the means of realizing the power are deficient. It is not lack of fuel which is the trouble, but rather it is a clogging of the wheels with dirt—the wheels, in this case, being the nerves and brain.

Every activity of the body is attended by the production of waste products, which must be removed if the body is to maintain its working efficiency. These waste products are normally carried off by the blood, in part as the result of a process of irrigation and in part by chemical means. Thus rest, after activity, is not a mere passive process. It is an active process just as work is. The engine has gone to the sheds to be cleaned, repaired, replenished. Time is clearly essential to the carrying out of this active process of recreation. A rule emerges:

"There will be a definite relation between the degree of any given activity and the time necessary for the completion of the subsequent restoration process. If the activity is repeated too quickly to give time enough for restoration after each action fatigue will become progressively more intense as the debit balance accumulates, and each repeated act in consequence will be more and more impeded

and will become smaller until further action is impossible."

It has been found by careful experiment that, so far as the nerves and nerve fibres, which connect the outside world with the brain on the one hand and the brain with the muscles on the other, are concerned, fatigue does not occur. At least, fatigue here is unrecognizable, probably because of the extreme speed with which nerves recover their full activity. As regards the brain, however, the matter is quite otherwise ; indeed, it is certain that the " receiving and distributing mechanisms " of brain and spinal cord become clogged up and so fatigued in the industrial sense considerably earlier than do the muscles themselves. It is thus true that the muscles are protected from great fatigue by the brain, for the latter cannot force them to act until they are completely exhausted. The brain itself, before this point is reached, is rendered incapable of giving any orders. Industrial fatigue, that is, a state of diminished capacity for effort, is therefore fatigue of the brain, though, in sensation, its effects may be referred to the muscles. The man may, and often does, feel that his muscles are exhausted ; in reality it is his brain which will work no more. On the other hand—the common case—he may, as we have pointed out, feel no sense of exhaustion and yet be suffering from a measure of fatigue which renders him a very bad investment so far as his employer is concerned.

This truth can be better understood when it is realized how a change of work will often banish a

sense of exhaustion which has come on during the performance of a particular task. The same muscles as were employed in the old are used again in the new activity. But now they feel fresh and eager once more. What has happened is that a new part of the brain has been called into play for the new effort. Fatigue has miraculously disappeared. In the same way a tired man walking by himself along a road will often, if he is joined by an interesting companion, lose all sense of tiredness and become completely refreshed—a new part of his brain has been enlisted.

It follows—and here is the big point for the employer—that a break in one form of work and a transference to another form of work may up to a point convert an industrially fatigued man into a fresh one, or, better still, may prevent the onset of fatigue and maintain full working efficiency over a considerable period of time.

Indeed, the problems of industrial fatigue are almost wholly problems of fatigue in the nervous system. The cells of a particular part of the brain, or rather of a particular " path " in the brain, have become overworked through handling too many messages. They are like a series of tired telephone girls ; they lose their alertness, they respond slowly to calls made upon them, they become incapable of the speed and deftness upon which a high rate and quality of output depend. They must be cleansed and restored.

Meanwhile another set of cells, another " path " in the brain, another group of telephone girls can

be called into play. These are relatively fresh and so may command the still unexhausted muscles with excellent effect.

In popular phrase, the man can "switch off" one form of activity and "switch on" to another, maintaining by this means, throughout a long period, his fullest efficiency. Whereas had he tried to carry on the first task only throughout the same period his working efficiency would have been seriously impaired and he would have become, during the latter hours of his labour, a poor investment for his employer's money.

We may now look at the subject more closely and grasp the fact that the principles we have enunciated depend on fundamental natural laws, to reckon with which is to succeed, to fly in the face of which is to court disaster. In nature, if we may so put it, great fatigue does not normally occur. That is to say, an overdraft on the bank of strength is not permitted. There is for every acting element "a given rhythm of activity which allows exact recovery after each act," and maintains the balance between action and repair throughout a long series. The heart is a splendid illustration of this. It will go on beating throughout a long life without loss of working capacity because the period of the beat and the periods of rest between the beats are so nicely adjusted that the organ is kept continually refreshed and restored.

There is reason, though, to think that this rest and action in the case of the heart—as in the case of other muscles—is regulated in the nervous system

and not in the heart muscle itself. In other words, that part of the nervous system governing the heart's action dictates the rhythm of the heart in accordance with its own and the body's requirements. The heart muscle itself probably does not therefore reach fatigue at any time.

This is far more important than might appear at a first glance. For not only does it throw a new light on those cases of "debility" and "weakness" which are the bane of every working organization, but it explains why fatigue occurs more quickly in one man than in another, why training will postpone the onset of fatigue, and why, by a combination of judicious selection of employees and proper care of them when selected, maximum work can be obtained with minimum exertion.

So long, in fact, as employers "thought in muscles," that is to say, thought of a man as having a certain amount of strength to expend, and as being able to expend it at the same level all the time, so long did they seem justified in acting as if the processes of the body had no bearing on their profit and loss account. The moment that "thinking in muscles" gives place to "thinking in brain cells" the whole situation is changed. Each cell has its rhythm of action and rest, and the nearer to these cell rhythms the hours of labour, the pace of machinery, and so on, are brought, the more effective and sustained will be the work done.

If the rhythms imposed from without are faster than the natural rhythms of action and rest, they must result in accumulated fatigue. Consequently:

"It is the problem of scientific management to discover in the interests of output and of maintained health of the workers what are the 'maximal efficiency rhythms' for the various faculties of the human machine."

Once these are determined, "pace" can be regulated so that fatigue is warded off as far as possible, and so that working efficiency is kept to its highest possible point during the whole period of work.

In order that employers may realize that these are no academic speculations but matters vital to industry, we may now come to consider some of the tests for fatigue. The first of these which was used by Dr. Stanley Kent during his studies on munition workers consisted in a method for determining what is known as "reaction time"—that is to say, the time which elapses between the receiving by the employee of a call for action and his response to that call. It is easy to see that the essence of efficient work is a short reaction time; the worker who is setting type, for example, carries out a series of movements which are dictated by the impressions conveyed to him by his eyes. The time which elapses between the point when he sees the letter to be "set" and the point when he actually sets it is his reaction time for this visual impression. If he is expert and fresh this time will be exceedingly short, it will lengthen as he becomes fatigued, until finally he must—if the process is continued—prove an unprofitable investment for the person paying him wages.

One of the tests used was as follows: The man being examined was required to depress a key which, at the same time that its movement was recorded on a revolving drum, closed an electrical circuit and caused a shutter to fall. This exposed a letter or a particular colour. The man had to recognize this letter or colour and then to select from six keys in front of him the one bearing a similar letter or colour to that exposed and to depress it. The result of depressing this second key was to produce a second mark upon the drum. The distance between the two marks—the rate of the revolution of the drum being known—was the reaction time for this complicated movement.

The accompanying figure (Fig. 1) illustrates the result of this test in a man employed in a munitions factory. The first value given, Monday's, is above zero, and so indicates that the reaction time in the evening was shorter than in the morning. In other words, this man was actually less fatigued when he stopped work on Monday than when he began to work on that day. It is pointed out, however, that Monday is a peculiar day in this respect, for a period of forty-two hours' rest had elapsed since the last work had been done, this period having the double effect of making the worker slightly "rusty" and also refreshing him. By Monday night he had returned to his old "form" and had not yet passed beyond the good effect of his rest.

Tuesday, which was a day of "overtime," saw a marked change. The point is now below zero, indicating that the reaction time was longer in the

evening than in the morning (by 42-100ths seconds in point of fact). The same thing occurred on Wednesday, also an overtime day. But on Thursday, when overtime was not worked, the morning and evening reaction times were about the same, indicating that fatigue had not occurred. Friday, an

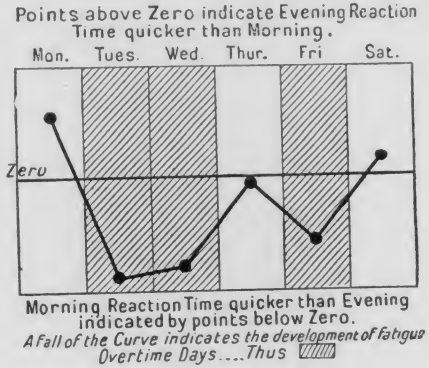


FIG. 1 (after Kent).

The graph refers to "reaction time," or rate of response. When this was shorter in the evening than in the morning the line is above zero, when longer it is below.

overtime day, at once lengthened the evening reaction time again, indicating fatigue. On Saturday, 12 noon, with the half-day work and the promise of rest, the fatigue disappeared and the man was better on quitting work than when he began.

In the second figure a different method of charting has been adopted. The differences between morning

and evening are not given as above and below zero, but are set forth quite straightforwardly as ups and downs, up being a shorter reaction time and down a longer one.

Here again Monday shows no indication of the development of fatigue during the day, but, on the contrary, improvement. During the night, however, the opposite effect is seen. Overtime leaves the

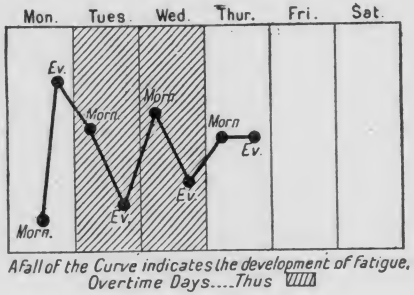


FIG. 2 (after Kent).

man with longer reaction times at the end of each day.

The reaction times for hearing and for sight alone were also taken, and the results were similar to those obtained for the more complex effort we have described. It is consequently evident that on the days overtime was worked in this factory the men were suffering from fatigue during a portion of their working hours. Their reaction times were longer, and consequently their efficiency as workers was lower. The meaning of this and its bearing upon

industrial accidents will be clearer when it is realized that the Royal Air Force refused to accept candidates whose reaction times were much above normal, as it was found that these men made bad aviators and were exceedingly apt to "crash."

This test of reaction time is a test of the nervous system, not of the muscles. This must be firmly grasped. It forms an indication of fatigue which is of vital importance because it has stood the test of practical application, as we shall show later. The employer, therefore, who keeps men at work until their reaction times become abnormally long cheats himself, inasmuch as he pays for what he cannot obtain. If he engages men, in the first instance, who through disease or other defect have abnormally long reaction times he also cheats himself. This has, of course, been understood roughly ever since man began to do work at all, and employees have been divided into quick and slow manipulators and so on. But science now offers precise tests to replace the rough and ready methods of other days. It is a safe prophecy that just as no insurance company could afford to dispense with medical examinations, so no great employer of labour will be able in the near future to dispense with the help which physiology and medicine can give him in this respect.

CHAPTER II

UNPROFITABLE OUTPUT

In the last chapter we gave grounds for the view that overtime labour is extravagant in the sense that payment is made for what cannot be obtained. We may now come to the more practical side of the subject and examine such figures as are available regarding the effect of fatigue with its prolonged reaction times upon actual output.

The material before us is that collected by Dr. Stanley Kent. While his figures refer to fatigue other factors certainly play a part in their production, for example, the circumstances of the worker, his skill, his physical condition and general health, his food, his mental condition, and so on. The experiments were made upon winders, surgical lint packers, and boracic lint packers.

The work in the winding room began at 6 A.M. and went on till 8 A.M. Half an hour was then allowed for breakfast. The next period of work was from 8.30 A.M. till 12.30 P.M., when there was an hour for dinner. From 1.30 P.M. till 5.30 P.M. work was carried on again. Those working over-

time now took half an hour for tea, which was provided, and then continued working till 8 P.M. The work took considerable exertion and great manual dexterity. Constant standing was necessary.

The duty of the worker was to replace bobbins working on a row of spindles as they became empty, and to replace reels on another row as they became

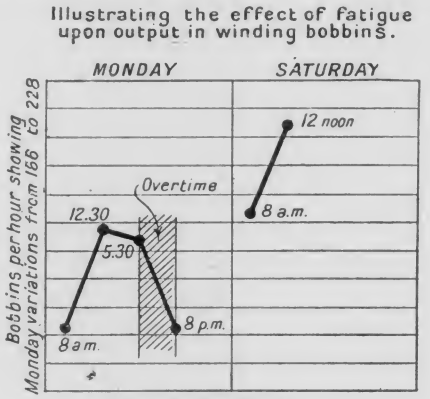


FIG. 3 (after Kent).

full, to tie up broken yarn ; the area covered by each worker was some 31 bobbins with corresponding reels. The worker had also to handle the baskets bringing new bobbins to the machines. The constant reaching over and removing of the reels is described as "by no means light work." Tying the ends of the yarn when it broke required great dexterity. The work was paid for at piece-rates.

A chart (Fig. 3) is given showing the average

number of bobbins per hour emptied by four workers on Monday and on Saturday of the same week. The actual figures are :

Monday.	Bobbins.
6 A.M. to 8 A.M.	166
8.30 A.M. to 12.30 P.M.	228
1.30 P.M. to 5.30 P.M.	225
6 P.M. to 8 P.M. (overtime)	167

Tuesday's figures were very similar. On Friday a higher level was attained though there was a fall during overtime. On Saturday the curve rose sharply. At the beginning of the week output was lowest during the early morning period. As the week progressed output during the early morning period improved, while, especially toward the end of the week, output declined during overtime.

These results were confirmed during a second experiment, and they tally in a remarkable way with the results obtained in other directions and by repetitions of the experiment (Fig. 4). Thus there is revealed in each day a double periodicity of low output—the early morning and 6-8 o'clock in the evening. A comparison between the average figures for these low output periods and those for the two higher output periods on Monday and Tuesday of one of the experimental weeks shows :

	Low Output Figures.	High Output Figures.
Bobbins per hour . .	166·35	223·27

This represents a difference of no less than 56·60 bobbins per hour, or 678 bobbins per day.

Saturday's high readings are explained by the approach of the week-end and the need of clearing the machines. When overtime was undertaken on this day (till 4.50 P.M.) the output fell very rapidly owing to the week's accumulation of fatigue.

The question at once arises: "What would happen if the working day were to begin at 8.30

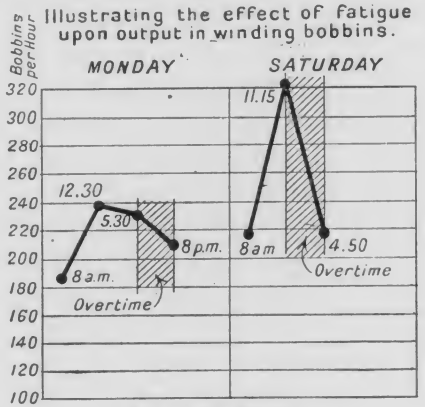


FIG. 4 (after Kent).

instead of at 6 A.M.? Would the unsatisfactory output be transferred to the later period or would it disappear?"

The matter was put to the test of experiment. Members of groups of workers began work sometimes at 6 A.M. and sometimes at 8.30 A.M. The following examples show the kind of results obtained.

No. 8 (winder) began work at 6 A.M. on Monday

and at 8.30 A.M. on Tuesday. The rate of working was 209 bobbins per hour when she began at 6 A.M. It was 262 bobbins per hour when she began at 8.30 A.M.

No. 14 (winder) began at 8.30 A.M. on Monday, her rate being 221. The average rate for the group in the 6 A.M.-8 A.M. period was 186. On Tuesday the same worker began at 8.30, her rate being 227. The average rate for the group for the 6-8 period, Tuesday, was 187.

General averages in bobbins per hour for the 6 A.M.-8 A.M. periods for five weeks were: 216, 253, 258, 261, 226. For the period 8.30 A.M.-12.30 P.M. for one week when early morning work was suspended the average was 316, or 55 bobbins per hour above the best figure of the early morning numbers. This can be shown in another way, as in the following table, from which it will be seen that the suspension of the early morning work not only cut out a period of low output, but also increased the output in later periods:

	Weekly Average Bobbins per hour for period 6 A.M.-8 A.M.	Weekly Average Bobbins per hour for period 8.30 A.M.-12·30 P.M.
Week before early morning period was suspended .	261	275
Week during which early morning period was suspended	...	316

Thus the early morning period may, in Dr. Kent's view, be said to bear the same relation to the labour

of the day as Monday does to the labour of the week :

" In both cases a cessation of work has produced a disinclination to recommence, to overcome which a distinct effort on the part of the worker is demanded."

What has happened is that the worker has got out of practice. Practice is necessary at the beginning of every period of work, the amount required depending on the duration of the preceding period of rest. On the other hand, fatigue, carried over from the day before, also plays a part, since by cutting out the early morning period a greater output can be secured on several days at least of the week, though notably not, as a rule, on Monday.

The employer is thus faced with a double problem. He must not, if he can help it, employ fatigued workers, because, if he does, he will get a smaller output than he might obtain with fresh ones ; at the same time he must avoid prolonging unduly the periods of rest, because if these are too long the level of " practice " will fall and a low output occur.

In this respect it is necessary to deal, not with weekly averages, but with individual days of the week. For example, Monday is a day on which early work is probably economically sound. The workers have had a prolonged rest, and are not at all fatigued. But they are considerably out of practice. It has been found that if the early hours of work (6 A.M.-8 A.M.) are cut out on Monday the output of later periods of the same day will suffer

because the lack of practice will remain, no matter when the work is begun, and will have to be overcome. From Wednesday onwards, however, this lack of practice becomes negligible. Much more important is the presence of accumulating fatigue. Therefore from Wednesday onwards it pays to cut out the early morning hours.

A further illustration of this is afforded by the following table, which deals with a group of workers, and is expressed in bobbins per hour :

Early Morning and Overtime.	Overtime abolished.	Early Morning abolished.
265·5	276	316

In one case a worker, on piece-work, found out for herself that it was profitable to avoid overtime and to cut out early hours. She usually worked only eight hours a day instead of twelve, and when asked the reason replied that the extra rest enabled her to work so much more quickly during the day that she was easily able to make up for lost time. Observations were carried out for twenty-five working days on this worker, and her output was contrasted with that of three of her companions who worked twelve hours a day.

For the whole period of the experiment the total bobbins wound by the eight-hour-day worker was 52,429. The average of the other three twelve-hour-day workers was 48,529. Thus the eight-hour-day worker was 7·5 per cent to the good.

It will thus be seen that, measured by the standard

of output, overtime and early hours during most days of the week were a failure.

Nor did the evil stop there. A man's health depends on his leisure. If he is uneconomically employed doing a twelve-hour day he cannot devote the necessary time to recreation. He deteriorates both as a man and as a worker. Consequently, the employer's loss in him increases progressively. The training in his work he has obtained, which had he been quite healthy might have been expected to improve with time and so become more valuable to his employer, is counterbalanced by diminished working capacity. A kind of vicious circle is established.

Fatigue, then, whether of the moment or carried forward from yesterday, is the great enemy of output just as it is the great enemy of health and pleasure and joy in life. It defeats alike the object of employer and of employed and is equally dangerous to both. The interest of the man is identical here with the interest of his master, and science comes as the friend of both. The enlightened employer, acting even on the most commercial motives, will see to it that he abolishes this enemy of his pocket from his factory. Acting upon higher motives he will be still more determined in such a course, for he will perceive that happy, contented, and vigorous workpeople are of the very essence of commercial success.

These remarks apply to healthy men and women. From work which has been carried out in other directions there has emerged the certainty that in

the unhealthy, fatigue is much more readily induced and much more lasting in its effects. Consequently, we must now discuss the question of the medical examination of employees.

It is a far more difficult question than is generally supposed or allowed, because involved in it are some of the most recent researches into physiological medicine, researches which are only now emerging, if we may so put it, from the embryo stage. However, a few simple propositions may be set forth in order to show the lines of thought which are likely to repay following up.

In the first place we must return to our previous statement that fatigue is a phenomenon of the nervous system, and not of the muscles. It is the nerve cells, or the nerve endings in some cases, which are tired; it is not the muscle fibres. Consequently, poisons which act upon the nervous system are direct inducements to the onset of fatigue. The poisoned man, the sick man, is thus an unprofitable investment from the outset.

This, of course, is obvious when we are dealing with gross disability. It is much less obvious and therefore much more important when we are dealing with men and women in the earliest stages of disease, before gross disability has shown itself. We make no apology for going very thoroughly into this matter.

Disease, as understood by the public, means something which lays its victim aside. But disease as it will come to be understood in the industrial world means something much more subtle. It

means the presence in the body of some poison which is not eliminated, and which goes on, day by day, reducing the "margin of strength," that is to say, the working capacity of the individual affected. It is thus the most costly of all enemies of industry and the most ubiquitous.

Let us take as a gross example the condition which is known popularly as "rheumatism." This in the public mind consists of certain pains in the muscles, a tendency to headaches, occasional "bilious attacks" perhaps, and a host of small, ill-defined symptoms. This disease is widespread and its true character is only just beginning to be understood. It is now recognized that, strictly speaking, there is no such thing as "rheumatism." Rheumatism is a name for symptoms, not a name for a fundamental disease. Almost all chronic diseases produce sooner or later rheumatic symptoms. For example, patients with dirty throats are very frequently afflicted with "rheumatism" from the poison coming from their throats. When their tonsils are removed their rheumatic pains disappear. The same applies to bad teeth, to those whose bowels have become sluggish, to those who have suffered from some acute illness which may not have been got rid of from the system, *e.g.* diphtheria, consumption, rheumatic fever, and so on. Patients with chronic malaria—and there are many thousands in England at this day—are notoriously liable to suffer from rheumatic pains, so are chronic dysentery and chronic trench fever patients. These men, in short, are the victims of a slow poisoning, and they

will continue to suffer until such time as the source of the poison is discovered and, if possible, eradicated.

Now, from the industrial point of view, the mere "pains" might not seem to matter very much. That has long been the prevailing opinion, and the fact that it has been the prevailing opinion accounts for the difference that exists concerning this matter. But, in point of fact, these "pains" are of far more importance than appears at first sight. They indicate, to the initiated, the presence of an agent which, day in and day out, is sapping away the vigour that should be at disposal for productive work, for output.

Let us see how the poisons operate within the body. It has recently been discovered and established as a strong probability that the poisons of disease act directly upon the nervous system, and that extremely small quantities of these poisons are sufficient to throw that system out of gear, to fatigue it, in short. Consequently, the very first symptom of the invasion of the body by a poison is a sense of exhaustion.

The various organs of the body, including all the muscles, are under nervous control. Not only so, but the blood-vessels which supply these organs are also under nervous control. When an organ is active the "sluice-gates" of its blood supply are thrown open by the nerves to its blood-vessels and at the same moment blood is driven out of other areas of the body and brought to the scene of action. The efficiency of any effort depends on a rapid and deft action of these various nerves. If for any

reason the nerves are poisoned so as to be over-excited, or under-excited, the mechanism breaks down and the easy task of yesterday becomes the impossible task of to-day.

We may prove this, for example, by observing a patient who is suffering from, say, chronic poisoning from the teeth. This man will be of a " nervous " disposition. He will tend to be excitable, to react strongly to slight causes, to sweat easily, to flush and pale at small provocation. He will be subject to tremors, to headaches, to rheumatic pains, and so on. If he be asked to draw a long breath and hold it, his pulse will slow to an abnormal extent, or else perhaps lose volume altogether.

This latter test, a new one, is important, because it reveals a failure of the nervous system to compensate quickly for a sudden change of blood distribution—in other words, the nervous system is poisoned, its balance is upset, responses and " reaction times " are disorganized.

This man belongs to the order of the chronically tired. He cannot undertake much exertion without great discomfort. He lacks staying power. He is a bad investment. He is, indeed, normally half-fatigued, and his rate of output is likely to be below that of a man who is not poisoned and so has no need to expend his strength in fighting an insidious foe within his own body.

Now it is quite clear that to employ such a man is uneconomic. His nerve cells are always in a state of fatigue—the first sign of fatigue is irritability. He will, so long as he remains poisoned,

fail to produce at the normal rate. He will tend to break down during any period of strain. He will tend also to precipitate accidents, because his responses to " emergency calls " will be below par. Yet he will look " quite well " on most days and he will probably declare that he is quite well—and believe it.

The wise employer will therefore perceive that these poisoned men and women should if possible be eliminated from his working staff—until they are cured. He will see that medical examination of an employee before he is engaged is a matter of great importance, and medical inspection during work no less important. The employee, too, will find it in his interest to support such examinations, because they will afford him protection against over-strain and secure him against the insidious onset of disease. The State should not be less concerned, for it is profoundly true that you cannot conduct an A 1 empire, in a business sense, on a C 3 population. Production demands health ; and disease is most curable in these early stages of which we have been speaking.

A works doctor, indeed, is a form of insurance that must soon become universal. It will be his duty to examine all applicants by the most stringent of modern tests. The easily tired, the breathless, the slightly exhausted, no matter how well they look, will be rejected by him after suitable testing. These men should then be advised to seek early advice—it may be hoped that the Ministry of Health will make provision for this—in order that the

nature of the poison present may be determined. If the trouble is teeth, a good dentist will put an end to it and the working efficiency of a good man be saved; if it is tonsils, a surgeon will remove these; if it is sluggishness of the alimentary canal, a physician may be able to alleviate matters; if it is malaria or dysentery, appropriate treatment will restore function to a great extent. Disease will have been detected and defeated at the outset before its grosser manifestations have had time to show themselves.

The works doctor will also keep all the employees under his constant supervision. As soon as a man or woman shows a falling off in efficiency under test, a search will be made for the cause of this falling off. Such questions as alcohol, food, housing will be inquired into—faults in all these produce an immediate effect on the nervous system comparable to the effects of disease—and then possible sources of poisoning will be looked for—*e.g.* early tuberculosis of the lungs, bad teeth, tonsils, bowels, infection by some fundamental disease such as syphilis, gonorrhœa, malaria, dysentery, rheumatic fever, and so on. The patient will be placed at once under treatment.

It will be seen that in thus serving his own ends the employer is also serving the best interests of his employee and of the State. It will also be seen that quite as much as the workman the master is interested in good housing and good health. In the absence of these he cannot get his full output of labour, no matter what wages he may pay. In-

deed, there can be little doubt that it would be profitable for employers to invest money in schemes of public health in the neighbourhood of their factories, for by so doing they would cut down the incidence of disease among their employees.

Indeed, there is absolutely no conflict of interests as between employers and employed and the general body of the public so far as health, hours of work, and hours of recreation are concerned. What is bad for one is bad for all. Here, then, and not so much in elaborate schemes of national health registration, lies the way of preventing and eradicating disease. The employer's enthusiasm must infect the worker not only because the latter will suffer if he does not pay heed, but also because every man desires, if the opportunity is afforded him, to be and to keep fit. Employer and employee will quickly bring their troubles to the notice of the authorities in order to secure help. Thus a new kind of "detective of disease" will come into existence in the shape of the works doctor. The works doctor will begin where the school doctor left off.

CHAPTER III

THE HOURS OF INDUSTRY

REPORTS received by the Chief Inspector of Factories show, according to Mr. R. E. Graves, that shortening of hours has been achieved mainly by means of three different systems :

(1) The one-break day system, under which work begins after breakfast and only one meal-time is allowed.

(2) The two day-shift system, under which work is carried on by two shifts of workpeople, each working from six to eight hours daily.

(3) The five-day week system, under which no work is done on Saturday.

In August 1917 the Huddersfield engineering employers and operatives agreed to give the one-break day system a twelve-months trial. This trial was found so satisfactory that in August 1918 it was mutually agreed to continue the system. The reduction of hours per week was from 54 to 50 hours—four hours. In Bradford the same system was adopted in June 1918. Here the 7.30 A.M. starting time was also adopted. As under this rule employees could not obtain a good breakfast at home,

means for making tea half an hour before starting time were provided. A firm manufacturing textile machinery reduced their hours in 1918 from 53 to 48, and adopted the after-breakfast starting time of 7.30 A.M. They furnish the following information of the results :

(1) The moulders on practically all jobs have made the same number of boxes per blow.

(2) Machinists (men and women on piece-work) have with one or two exceptions earned the same wages in the reduced period.

(3) Time workers were doing as much as before.

(4) As regards time-keeping, under the 53-hours week 14 to 17 per cent of the men and 17 to 25 per cent of the women arrived late. In the same period under the 48-hours week only 1 to 1¼ per cent of the men and 1 to 1½ per cent of the women arrived late.

From an engineering works at Bristol, employing over 600 hands :

the manager, noticing that the time-keeping before breakfast was very bad, that the men were not fully awake, and that the work done then was obviously inefficient, called a meeting of the men in 1913 and proposed to change the hours from 6 to 5.30 (less one and a half hours for meals) to 7.30 to 5.30 with one meal hour (thus reducing the net weekly hours from 54 to 50), with no reduction of wages. A six-months trial was agreed to, and the system was found so satisfactory that the new hours were confirmed. It was found that very little time was lost and that the output had increased.

No case has been reported of an engineering

establishment which has once adopted the one-break day reverting to the old system. On the other hand, a firm of iron-founders in London, who reduced their weekly hours from 54 to 52 by adopting the period 7.30-6 with one break (instead of 6-5, with two breaks), changed back to the old system, because " the men objected to the later finish, and also because they could not always get breakfast at home before starting." The firm state that time-keeping was better under the new system, but some output was lost.

In the hosiery and woollen and weaving factories in Scotland an after-breakfast start is now almost universal. Reports declare that it is becoming popular, even those employers who objected to it having been won over. For example, the principal of a large textile factory says :

Our opinion is that the new system is excellent, and our experience fully justifies its adoption, for it is advantageous to both employer and employee. Under the old system the average earnings were 22s. 6d., and the loss of time 5·5 per cent, while on the new system earnings average 25s. 1d., and the loss of time only 1·8 per cent.

A worker, when asked to explain the fact that her earnings had not fallen off in spite of the fact that the machinery was running at the same rate, declared that this was because " we have only one break instead of two ; we never worked as well before breakfast as after it, and we are now fresher at the end of the day than formerly."

Data regarding the effect on output are still rather

scanty, but the general opinion seems to be that little alteration has taken place. A firm of spinners and weavers in Wales reduced their hours in the weaving sheds in 1913 from 52½ per week to 49½. This was found satisfactory, and the system was extended to the spinning department with the promise that if output was maintained, no reduction of wage would take place.

Employers in Belfast have formulated their views on the shortening of hours, and these may be set forth in this way :

(1) They will be able to draw from a better class of labour.

(2) It is bad for the workers to have to come out before breakfast, especially in winter, and the children of the married women suffer considerably under the long hours as they have to be taken in " to nurse " before the mothers go to the mill in the morning.

(3) Shorter hours increase the efficiency of the worker.

(4) Shorter hours improve time-keeping.

On the other hand, it is feared that there may be—and this applies especially to the spinning industry—decrease in output and increase in the cost of production. If cost of production rise beyond a certain limit, linen, being more or less an article of luxury, will be replaced by a substitute of some sort. Moreover, foreign competition may be serious if no safeguards are secured.

We have already shown that so far as munition factories were concerned output did not fall when somewhat shorter hours were worked ; on the con-

trary, the absence of fatigue made the hours of work under the new system more productive, and the loss of time was made good. This experience is not confined to munition workers. At a large soap factory the weekly hours were reduced from 53 to 48⅔, and again, two years ago, to 44. The experiment was successful. It was found that by speeding up the machines even machine workers could get the same output and earn the same wage as before with less fatigue.

Again, at a cotton thread works in Yorkshire, where the system of shorter hours has been in operation for seven years, the weekly hours have been reduced from 55½ to 49½. Entire satisfaction to employers and employed has resulted. The majority of the operatives are on piece-work, and the piece-rates have not been changed. The output fell at first in proportion to the reduction in hours, but "it gradually rose during the following four years till it reached the old maximum, which has been maintained ever since. The cost of production remains about the same as before, time-keeping has improved, and absence from sickness has been reduced."

There are some objections to the new system, however. In the first place, breakfast before starting for work leads to an increased consumption of coal and gas in the home. The interval between breakfast and dinner is regarded by some workers as too long (even where work begins at 8 A.M., the worker must have breakfast as early as 7 A.M. and often much earlier, and this meal is not likely to be

very satisfactory). The remedy suggested is that a short break should be allowed during the morning spell or light refreshment should be sent round in a wagon, as is done in some cases. Further, it is said that confusion is apt to be caused in the worker's home when some members of the family work under the old and others under the new system. The worker's wife must rise very early to cook his breakfast instead of merely preparing this overnight. Under the old system any hot drink or food was prepared by the worker himself.

Against these objections, which are urged by the workpeople themselves, may be set the fact that under the new system workrooms are more comfortable, particularly in winter, when they can be properly warmed before work begins, and the employees get more sleep. Moreover, people go to bed later nowadays and thus feel the effects of an early start more.

The two-day shift system involves work in shifts between, usually, 6 A.M. and 10 P.M. It is thus not permissible for women and young persons under the provisions of the Factory Act. Inspectors report that where it has been employed few objections have been raised against it. Indeed, many workers express themselves as well pleased. Nor have administrative difficulties been encountered. As a rule Shift I. works Monday to Friday 6 A.M. to 1.30 P.M. or 2 P.M., and Saturdays 6 A.M. to noon, with half an hour for breakfast. Shift II. works Monday to Friday 1.30 or 2 P.M. till 10 P.M., with half an hour for a meal about 5 P.M. and no work on Saturday.

In a chocolate factory working 6 A.M. to 1 P.M. and 1 P.M. to 8 P.M. the scheme is said to be very satisfactory to both employers and employed; the output is at least 50 per cent greater than under the old hours (9 A.M. to 7 P.M.). Some workers declared that they much preferred the two-shift system and were in better health on account of it. The system also puts an end to overtime, which has been shown by experiment to be a costly and unproductive method of work. The volume of available employment is incidentally increased. In several cases, it is stated, the adoption of the system has enabled a firm on ceasing war contracts to avoid discharging numbers of its workers, to absorb demobilized men, or to take on women discharged from neighbouring munition works. The system also affords a means of increasing total national production and of decreasing the cost of production.

Finally, there is the five-day week system. It is not, so far, on a very satisfactory footing. At one large textile factory where it was adopted on trial for some time the output fell off so much that the firm changed to a six-day week with an after-breakfast start at 8 A.M. and one meal hour. The result of this second change was that, notwithstanding shorter weekly hours, the output increased again.

It becomes clear therefore that under either the one-break day system or the two-shift system shorter hours can be afforded without much immediate risk to the employer in respect of output and with very distinct advantage to him in respect of health, good time-keeping, and general well-being of his workers.

The workers, too, when adjustments have been made for certain details of the scheme, stand to gain, for they obtain more leisure and do not suffer loss of wage. They become healthier and thus better members of the community. The community as a whole benefits in the benefit of each of its members and does not seem to lose in respect of greater cost of production.

The results of the shortening of hours below the figures we have quoted remain to be seen. It will be information of intense practical and physiological interest, for it is quite clear that the optimum working time for industry in general has not yet been determined with a sufficient degree of accuracy.

CHAPTER IV

THE HUMAN MACHINERY

UPON the health of the nation trade and commerce rest as upon the only sure foundation. For this reason the report *On the Physical Examination of Men of Military Age by National Service Medical Boards* is a document of vital interest to the trading and manufacturing community.

A word of caution is, however, necessary in studying the figures. They refer to examinations carried out from November 1917 to October 1918—that is to say, to examinations during a period when it might be assumed that the best men in the country had largely been recruited, and that what was left over was indifferent material for the most part—though no doubt some good men in a physical sense were " released " to swell the ranks at this time.

This view has indeed been advanced to discredit the figures presented. It is not entirely trustworthy. The report states that as the figures include a very large number of men in protected industries, which in the nature of things employed fit workers, men previously rejected when the need

for them was less urgent, men now refused exemption by the tribunals, lads attaining the age of 18, and a small number of men between 41 and 51, they may be taken as fairly representative of " the manhood of military age of the country in the early part of the twentieth century from the standpoint of health and physique."

Of the 2,425,184 men examined 871,769 were placed in Grade I., 546,276 in Grade II., 756,859 in Grade III., and 250,280 in Grade IV. This may be expressed as follows :

Grade I.	. . .	36 per cent.
,, II.	. . .	22-23 ,,
,, III.	. . .	31-32 ,,
,, IV.	. . .	10 ,,

Thus, only one in every three had attained the full normal standard of health and strength, and was judged capable of enduring physical exertion suitable to his age. Again, about one in every five went into Grade II. as capable only of undergoing such physical exertion as does not involve severe strain. One in every three presented marked physical disability (Grade III.)—the so-called " C 3 " population. Finally, one in ten were judged to be " totally and permanently unfit for any form of military service."

The standards applied were necessarily of great importance. So also was the method of measuring the fitness of any given group of men. In its simplest form the idea was that each Grade I. man should count 1, each Grade II. man $\frac{3}{4}$, each Grade III. man $\frac{1}{2}$, and each Grade IV. man $\frac{1}{4}$. Thus, if a batch

of men had 893·75 units of fitness, on the above method of calculation it might be said to have an "Index of Fitness" of 89·37 per cent.

This index of fitness was determined in an attempt to discover the relations of occupation and health—the first attempt of this kind ever made in England. The following table shows some of the results obtained :

Occupation.	Index of Fitness.
Standard (Professor Keith)	89·3
Agriculturists	89·9
Miners	86·8
Agriculturists (another group)	85·9
Engineers	85·9
Iron and Steel Workers	85·7
Lace Workers	77·9
Woollen Trade	77·4
Woollen Trade (another group)	75·7
Tailors	69·5

In the western valleys and eastern portions of Carmarthen the percentage of Grade I. miners was higher than in any other part of Wales. The miners here are usually the sons of farmers. The man is born and bred on the land, in healthy surroundings, very different from the conditions obtaining in the case of most industrial populations. The coal seams, too, are high, and there is little dust. Housing conditions are good. Miners generally, indeed, furnish good recruiting material, being generally well fed and well developed—facts which speak well for their sporting instincts, love of exercise, good feeding, and high rate of intelligence.

The physique of the metal worker, on the other hand, is poor—"doubtless because he works in a superheated atmosphere, and has to stand for long hours upon hot surfaces." The evil effects of certain types of work—which effects can often be, and ought to be, prevented—is shown by the following table :

INDEX OF FITNESS

Combined average gradings of Boards examining mainly Colliers in N.W. region	87·5
Combined average gradings of all men examined in Great Britain in April 1918	81·5
Grading of 290 Cotton-operatives examined by Stockport Board, on April 5, 6, 8, and 9, 1918	57·9

The comment made is : "A remarkable and arresting illustration of the effect of our industrial system upon the health and physique of one class of workers."

The causes of rejection are of great interest. The following table speaks for itself :

200 YOUTHS OF 18, 19, AND 20 REJECTED

Poor physique	20	Mentally deficient	5
Physical defects	49	Skin diseases	4
Tubercle of lung	36	Bronchitis	3
Tubercle of other organs	2	Goitre	2
Heart disease	26	Graves' disease	2
Eye diseases	12	Nephritis	2
Deaf and dumb	8	Otitis media	2
Epilepsy	6	Other diseases	5

Perhaps the most extraordinary table illustrating the causes of rejection is that given for the London region. In this region 160,545 men were examined during the period January-October 1918. Of these no fewer than 15,947 were rejected for heart diseases—very many of which are due to infections incurred

since childhood. Consumption claimed 4327, other tuberculosis 911, and syphilis 556. No fewer than 48·5 per cent were unfit for Grade I.

The report illustrates also the fact that the youth coming to the army in the latter days of the war was far from being as fit as might have been expected or hoped. During the period under review 261,137 boys born in 1900—*i.e.* about two-thirds of all the boys who became 18 in 1918—were examined and graded with the following results :

1. A deficit according to standard expectations of nearly 13,000 Grade I. youths.
2. An excess of over 6000 Grade IV. youths, or, in other words, almost double the number of youths unfit for service—" totally and permanently " which there should have been, judged by Keith's Standard.
3. A total deficit of more than 11,000 units of fitness (4·3 per cent).

The following table should also be studied :

834 Youths of 18 examined by a Liverpool Board

Grade I.	Grade II.	Grade III.	Deferred and Unfit.
361 43·3%	189 22·6%	49 5·9%	135 16·1%

Average height . . . 5 ft. 5 in.
,, weight . . . 114 lb.
,, chest girth . . 30.7 in.

In the light of this and other returns it is inferred that a combination of height, 5 ft. 5 in., weight 116 lbs., and chest girth 32 ins., represents the

average standard which the youths of the North Western and West Midland regions attain at 18 years of age. The comment is made : " We cannot doubt that these proportions would be greatly improved by better conditions of life and environment during childhood, boyhood, and especially (as the results of army training have demonstrated) by better food, and better opportunities for physical development."

This is the moral of the figures for the statesmen, educational authorities, doctors, and men of commerce who may take the pains to study them—that all this waste of strength, and so waste of working power, is capable of being prevented. It represents dead loss. It has to be paid for twice over, first, as a burden on the community, and, secondly, as a loss of energy which might, had other methods been employed, have been available for the benefit of the trade of the country.

There is, indeed, no proper division of health care into " care at school," " care in the factory," " care at home," and so on. The nation's health is truly " one and indivisible." It is a chain every link of which is vital. By that chain hangs the nation's strength, its trade, its industries, its future.

The following graphs are taken from the report :

[Table

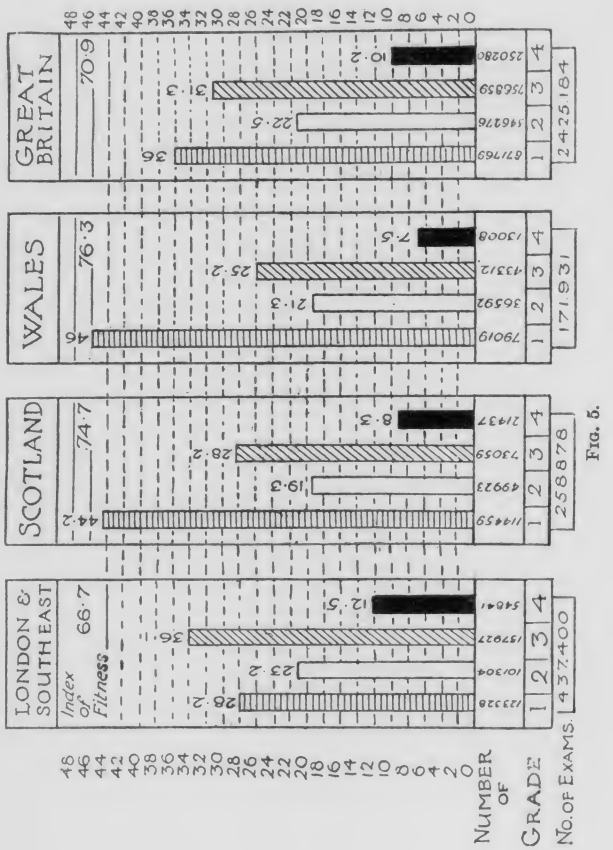


Fig. 5.

We propose now to view the subject from a somewhat different angle, and examine the returns of physical efficiency in its relation to specific trades for the London area.

We may take first of all those trades classed as "indoor sedentary"—*e.g.* clerks, piece-workers in the cloth trade, tailors, bootmakers, printers, compositors. These occupations produced some 25 per cent of Grade I. men, some 23 per cent of Grade II. men, some 39 per cent of Grade III. men, and 12 per cent of Grade IV. men.

When we come to analyse the nature of the diseases which afflicted these 51 per cent Grades III. and IV. men we find that pulmonary tuberculosis accounted for by far the greater number of Grade IV., and valvular disease of the heart for by far the greater number of Grade III. men. Indoor sedentary workers may no doubt in many instances choose their occupations because they have lung or heart disease, and it would not, therefore, be fair to ascribe to the occupation the cause of the malady. On the other hand, the idea that many victims of pulmonary tuberculosis—"consumption"—are employed indoors is a very disquieting one. It can only mean that many healthy persons are infected by them, and that consequently the danger of consumption to workers in the cloth trade, tailoring trade, printing trade, and so on is greater than it need be.

If we compare these indoor sedentary with indoor active trades—*e.g.* hotel porters and servants, indoor servants, excluding waiters and chefs, shop-

keepers and shopkeepers' assistants (other than those concerned with food supply), teachers, legal profession, dental profession, chemists, etc.—we find that while the percentages of Grade II. and III. men are almost identical, the diseases chiefly causing these percentages are rather different.

Consumption is still responsible for a large number of Grade IV. men, but equally bad in this respect

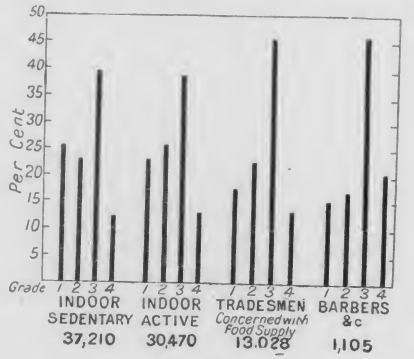


FIG. 6.

is "deformity," including flat feet, hammer toe, and spinal curvatures. These deformities also account for many Grade III. men. Occupations such as shop assistantships demand constant use of the feet and prolonged standing about. It is manifest that no man (or woman) who shows signs of weakness in muscles or joints should be permitted to enter these callings except under medical supervision. Heart diseases are also prevalent in this group.

Coming to the case of the tradesmen—*e.g.* shopkeepers and assistants handling food, milkmen, waiters, chefs, and so on—we find a marked increase in Grade III. men and a slight increase in Grade IV. The marked increase can be traced to the following: (1) Deformities; (2) diseases of the lungs other than consumption, which is, however, sufficiently prevalent; (3) diseases of the heart, and diseases of the veins—*e.g.* varicose veins. Even worse than the case

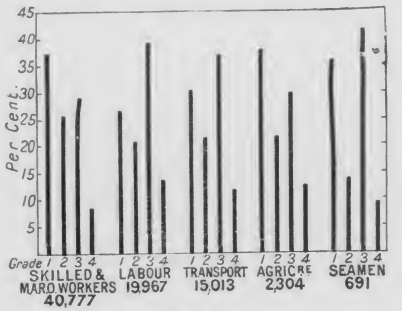


FIG. 7.

of those handlers of food—which is bad—is that of the barbers and manicurists, which is the worst of all. This group has the highest Grade IV. percentage of any—more than double that of the "skilled workers." The disease mainly responsible is consumption, and it is an uneasy reflection.

In remarkable contrast to the state of matters in these trades is the position with regard to the skilled workers—*e.g.* munition workers, shipbuilders, plumbers, gasfitters, carpenters, engineers, painters,

blacksmiths, etc. Here we have a very high percentage of Grade I. men and a very low percentage of Grade IV. men. Consumption is much less prevalent, but heart diseases seem to be relatively common.

"Labour," including unskilled labourers, scavengers, dockers, etc., shows a less advantageous

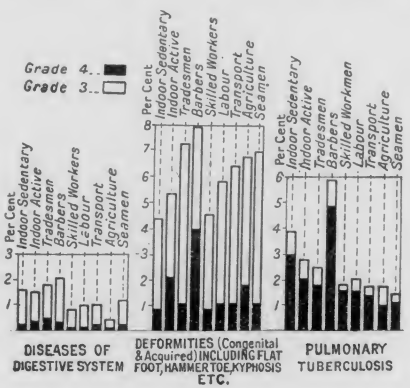


Fig. 8.

return than that of the skilled workers, and a similar state of affairs exists for the transport workers—*e.g.* outdoor porters, messengers, cabmen, taxi-drivers, omnibus and tram drivers and conductors, carters, draymen, postmen, railway porters, and servants.

This analysis makes it clear that the three diseases which are most destructive to industrial efficiency are "deformity," "consumption," and "heart

disease." The first may not, it is true, hinder a man or woman from performing a sedentary occupation. But this is a narrow view of the subject. In no occupation is a deformity an advantage either to master or man. It limits movement, it inflicts pain and weariness, it exhausts strength, and induces

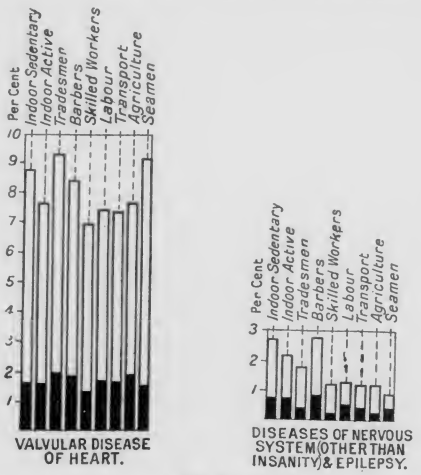


Fig. 9.

fatigue. It is thus a true enemy of industry, of output, of progress. Consumption and heart disease are, of course, enemies of the most immediate and deadly character.

The tremendous economic importance of these groups of diseases is evident when we compare in a graphic manner the records of digestive disease

or nervous diseases with the records of deformity, consumption, and heart disease.

If now we look at these diseases in relation to age we find that at all ages they remain dominant.

These figures refer only to the London area, but they are more or less representative. They teach the plain truth that if we could cure deformity in childhood, when it usually begins, prevent consump-

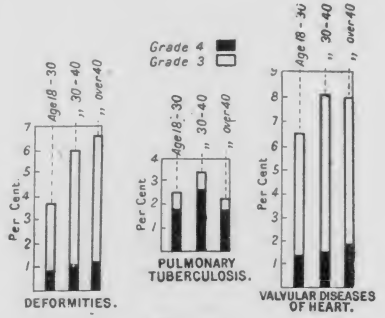


Fig. 10.

tion, and handle the problem of heart disease—a far bigger and more complicated subject than the public has yet begun to realize—we should add immediately and enormously to the working power of the nation as a whole, and so to the efficiency of all our industries.

The immediate lesson of this very exhaustive and very fascinating inquiry is that the problem of industrial health is always twofold. There is the question of suiting the worker to his work, and there

is the question of preventing his work from making a fit man unfit. The deformed worker is unhappily —as a result of the war—all too common a sight in our shops to-day. We must, in our own and in his interest, see to it that his labours do not exaggerate his deformity and so lower his productiveness. The consumptive worker we must look for, find, and exclude before he has infected others.

In what way, then, can employers of labour hope to rid themselves of this great incubus of disease? Are there any steps which can be taken at once? We may well turn to examine the problem in the light of modern progress.

The question of deformity, as we have indicated in former articles, is certainly the most urgent of all, because the war has left a terrible legacy in this respect. Deformity is largely preventable. With this aspect of the matter we shall deal in a moment. But even deformity which has become established is a relative rather than an absolute disaster. If the man is set to work to a task which demands two hands and he possesses but one he is an inferior craftsman. But if a method of work be devised in which one hand may serve for two his capacity may not be lowered after all.

This fitting of the worker to his work is now a branch of what is called orthopædic surgery. In its ruder manifestations that art has long been practised. But war surgery has evolved many new methods. Thanks to the skill and care spent on this branch it is now possible to render all but the most hopeless cases fit for a large measure of activity.

The medical man can help here in a very real way. At the present moment Great Britain can boast of the most distinguished school of orthopædic surgery in the world. At the head of this school stands Sir Robert Jones, its founder, to whose work and inspiration it owes indeed its very existence. If those manufacturers who have signed the King's Roll of Honour would invite Sir Robert Jones to nominate one of his pupils as their adviser, there can be but little doubt that they would quickly profit by this measure. Lines of action would be suggested to them which would increase the productiveness of their disabled workers. The subject has been fully studied at a large number of centres, and special trades have been brought under observation. It is a great pity that the manufacturers of the country should not reap the benefit of this special knowledge.

But if it is to the immediate interest of trade that every disabled man should be able to do work to the fullest of his power, it is equally to its interest that deformity and disablement should be stamped out altogether. Some time ago Sir Robert Jones outlined a great scheme which has in view the cure of crippled children throughout the length and breadth of the land. Disablement is curable in early years, he pointed out, and the good can be achieved with small difficulty if a proper organization exists. He proposed to take over the orthopædic hospitals one by one from the Ministry of Pensions and turn them into centres where deformed children could be reformed.

To some employers this may seem a project far separated from industrial hygiene. But a little consideration will show that this is not the case. The deformities of to-day must make the inefficient workers of to-morrow unless the weaknesses which cripple are dealt with and cured. This is Sir Robert Jones's case. If the employers of the country would rally to his side, his great project would certainly be realized. In ten years the huge volume of deformity would be reduced to reasonable proportions.

The case of consumption is rather different, but here likewise we discover the possibility of immediate action and also of more remote measures of prevention. We have shown that consumption was one of the great causes of rejection for the army. We have also shown that this disease was found to be prevalent in almost all industries. It is quite clear, then, that industrial life is a potent factor in the dissemination of the disease.

This idea cannot but reveal to the whole body of industry the danger which it is so lightly courting. In a vast number of workrooms and factories the deadly tubercle bacillus is being blown about and inhaled by men and women so far healthy. The unsuspected case, closely associated with his fellows in hot atmospheres and crowded spaces, is dealing out sickness and death, converting an A 1 population into a population fit only for C 3. In a larger sense he is impeding the human machinery of industry, breaking it down, and so causing great loss to those whose welfare depends on the efficiency of the machine.

It is really amazing that at present so little care is expended to prevent persons infected with tuberculosis from being engaged for work in areas in which they cannot but prove a menace to every one associated with them. One might have supposed that every employer would perceive how badly he studied his own interest in allowing his workpeople to run this great risk. The State, too, has the clearest possible interest in preventing what is nothing other than an invitation to calamity.

There is only one remedy—medical examination before engagement. This should be instituted by every employer. The small cost will quickly be made good in increased health and well-being. If the employers fail, the workpeople in their own interest are certain to take active measures very soon; for medical knowledge is spreading among the people and medical dangers are becoming more keenly appreciated. The table on following page, extracted from a report from the West Midlands district, illustrates the enormous influence of industrial occupation on the incidence of consumption, and shows also that those who lead an outdoor life reap a great benefit.

It will be seen that clerks and engineers were the worst sufferers. The clerk from his mode of work is in a position the most favourable for disseminating the disease.

[TABLE

TUBERCULOSIS

Occupations.	Birmingham.	Burslem.	Dudley.	Worcester.	Coventry.	Shrewsbury.	Hereford.	Leamington.	Walsall.	Wolverhampton.	Total.
Actors	1	..	..	..	1	..	..	..	..	1	3
Bakers	1	..	..	1	..	..	..	..	2	1	5
Boat builders	..	..	..	..	..	..	..	1	..	..	1
Boatmen	1	..	..	..	..	..	..	..	..	..	1
Brass workers	20	..	..	1	..	..	..	..	3	..	24
Brewers	2	..	..	..	..	1	..	..	3	1	7
Bricklayers	1	6	..	..	1	2	..	..	1	1	12
Butchers	1	1	..	1	..	..	..	..	..	..	3
Carpenters	11	3	1	3	..	7	..	2	6	1	34
Carters	10	4	..	..	..	3	..	1	3	5	26
Chauffeurs	1	1	..	..	1	2	2	3	3	..	13
Clerks	38	15	2	7	3	12	3	11	22	3	116
Colliers	..	22	2	1	1	5	2	2	14	1	50
Doctors	4	5	..	..	..	3	1	..	2	4	19
Engineers	72	24	5	5	16	3	1	12	21	19	178
Factory workers (textile)	10	..	..	1	..	1	..	1	4	..	17
,,	1	11	..	1	2	..	..	3	1	1	20
Farmers	..	..	..	1	..	4	1	..	..	..	6
Farm labourers	..	..	..	2	..	3	..	1	4	..	10

It by no means follows, however, that because a man is affected with tuberculosis industry is done with him. Were that the case the community must support a really huge number of persons capable to a greater or less extent of earning their own livings. What is required is a choice of employment and a careful medical supervision.

The late Sir Robert Morant, whose untimely death has robbed this country of one of its greatest health authorities, was deeply impressed by the need of action by the State in the direction of the employment of the consumptive, and after long and patient investigation inclined to the view that the "village colony" system offered the best solution. The idea is really a working colony living in conditions favourable to the affected person and carrying

on forms of employment which are suitable to the physical state presented.

Most employers, and especially those who take a personal interest in their workpeople, have learned to their cost that when a man is sent away for sanatorium treatment and returns later "cured," the period before a further breakdown occurs is usually short. Sanatorium treatment has consequently fallen into disrepute. The real cause of the failure is seldom understood. It is that the man returns from good conditions in which he did well to bad conditions—especially bad home conditions—in which he does badly. He loses his "sporting chance," so to speak, and relapses into chronic ill-health. Moreover, he begins to infect his fellow-workers.

The colony system is designed to prevent this. It is recognized that once a man in general employment shows signs of tuberculosis he should make up his mind to change his mode of work. His employer should understand that the best thing for all concerned is that this man should not—at least for a long period—return to office or workroom. He should go, in the first instance, to a sanatorium and then to a village colony, where in course of time he may become once again a useful member of society, where he will be under constant medical supervision, and where he will not, in any case, infect healthy persons with his disease.

The success of the village colony scheme depends to a great extent on the support which it receives from the great—and small—employers of labour. If they adopt an enlightened attitude the scheme

will be established and industry relieved of a great danger and burden. If, on the contrary, they refuse their support no progress can be made. Let them recall the terrible fact that 50,000 persons, mostly employed in industry, die of tuberculosis every year, and further, that there are some 90,000 fresh notifications of tuberculosis every year. The village colony at Papworth, in Cambridgeshire, is a model of what ought to be and can be done. A visit to that place would open the eyes of many a business man to the vast importance of the cause which we are now pleading.

The third and last of the great disabling diseases is heart disease. We are here considering what has become one of the most difficult problems of modern medicine, for, thanks to the work of Sir James Mackenzie, it is becoming increasingly clear that heart disease is seldom a separate entity, but most commonly owes its origin to some infection which has become established in the system. This view is not so revolutionary as it may appear at a first glance, because it has been known for years that rheumatic fever was a fruitful cause of heart mischief, and the same can be said of syphilis. But the modern idea is much wider and more comprehensive than that of older workers in this field. It embraces indeed a host of small troubles curable in childhood, incurable in later life.

The first point to be grasped by every employer is that heart disease very seldom arises by itself—it occurs as a second stage of some other condition. This other condition is frequently curable. Conse-

quently, if an employer has the benefit of medical advice he can—by attention to the small complaints of his workpeople—ward off the greater complaints.

Let us take a few illustrations. It has been shown that heart conditions are apt to follow infectious fevers like influenza and pneumonia. They occur very often in men afflicted with tuberculosis and syphilis and rheumatic fever. They are common after ear trouble, throat trouble, abscesses, and derangements of the digestive organs—notably constipation. All these ailments can be dealt with if workpeople are under regular medical supervision. To deal with them is to restrict and check their serious consequences and so protect industry from one of its worst enemies.

The truth is that heart disease, in a broad way, represents the results of untreated and unchecked infection. It thus represents the failure of industrial hygiene. Where it is prevalent the slightly unfit are being turned into the very unfit; the skilled worker is being damaged so that his skill is lost to his employer. For the same poison which affects the working of the heart affects also the working of all the other organs. It affects the nervous system and produces a state of fatigue and irritability. The man cannot give of his best. He "drags" through his work for years before the final breakdown occurs. He is a bad investment.

So accustomed has the public become to regard heart disease as a manifestation of the action of fate that this view is very difficult to assimilate. It is easy to persuade people that consumption is an

infectious disease which can, and should, be controlled. They know of the bacillus of tuberculosis and can understand how this bacillus may be carried from one worker to another. But they have great difficulty in seeing how the infections which originate heart disease can be so transmitted. They do not, indeed, recognize that infections do originate heart disease.

And yet the evidence on this point is becoming almost overwhelming. No one seriously disputes that rheumatic fever is apt to be followed by a heart infection. Recent work—work which is at present being carried on—strongly supports the idea that rheumatic fever is due to a bacillus and that this germ lives in the throat and can be transmitted from one host to another. Again, no sort of doubt exists that syphilis is a frequent cause of heart trouble. Yet so far the employers of the country have taken no part, or only a very small part, in the campaign to prevent the spread of venereal diseases.

Again, bad teeth, with dental abscesses at their roots, are a common source of poisoning and of ill-health. Here is a fruitful source of heart mischief, as any dentist will testify. When the heart becomes affected the worker is lost and it is too late to do anything. But had the teeth been looked to in the first instance the disease would have been prevented. Bad teeth, again, lead to bad throats, which are infectious. Thus one foul mouth in a factory or workshop may become a focus of disease and may be the means of robbing a firm of invaluable employees.

It becomes evident, then, that immediate action against heart disease, as against consumption, consists in adequate medical examination, not only at entrance to the works but also at intervals. Happily many firms have realized this. Those firms which lag behind will receive some help from the new Education Act, which aims at sending every schoolboy out into the world of industry with a health-record carried on from his infancy.

The time has certainly arrived when employers should establish close relations with the juvenile employment boards, which again are in close relations with the schools. In this way industry will be able to protect itself against the unfit and will at the same time begin to exercise pressure on the school medical service to prevent unfitness. The heads of the business world do not as yet realize how immediate would be the response to a demand made by them for fit youths to fill the ranks of their workers, and how, were they able to emphasize the present low grade of industrial health by reference to medical statistics collected in their own factories, this complaint would stimulate the efforts of the health authorities. Disease flourishes in this and other lands because it has not yet come to be looked upon as a crime. When industry begins to demand health industry will assuredly get it. All our administrators know that if only commerce could be enlightened on this point the battle against sickness would be as good as won.

Progressive firms now employ doctors. These doctors report fully on the state of candidates for

employment. Thus the consumptive is prevented from entering shop or workroom. The victim of bad teeth is refused work until such time as his teeth have been put right, or until he has visited the works' dentist. Thus a potential cause of heart disease and a potential enemy of industrial efficiency is either got rid of or turned into a sound and useful

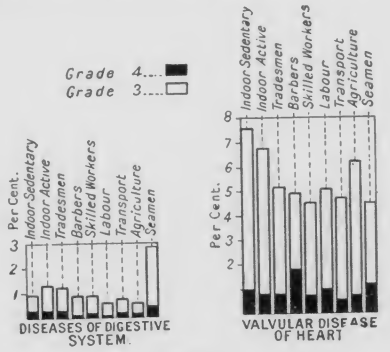


FIG. 11.

Comparison between valvular disease and digestive disease in an English area.

worker, a man, in the phrase of a well-known business man, "worth teaching his job." Again, the possessor of a foul or relaxed throat is ordered to have treatment for the same, and so prevented from setting up an epidemic of tonsillitis in the establishment, which epidemic might conceivably rob the employers of their most valued servants.

The victim of venereal disease is eliminated or handed over for cure. Another grave danger is thus

averted. The worker whose digestion has been ruined by improper feeding is given a chance to regain his strength or advised against a type of employment which could only result in further damage. The sufferer from skin disease is prevented from becoming a menace to all his fellows. Not only so, but a regular system of inspection eliminates small diseases which, soon enough, would develop into serious maladies.

This policy, then—the employment by every industry of medical inspectors and referees—would do more to prevent the spread of disease than almost any conceivable measure, except, perhaps, the school medical service. It would strike at the roots of what are called the "killing diseases"—especially heart diseases. The result would be a safer middle age and so a more productive middle age. Every employer knows that the workers of greatest value to him are those who possess the highest degree of efficiency. They range, as a rule, from 30 years of age upwards. That is about the age when the "killing diseases"—the plants raised from the seeds of trifling afflictions—begin to manifest themselves. These "right-hand men" are thus too often lost for want of a little care.

No employer would dream of leaving trifling ailments in his machinery untended. Our business world has many maxims, but none more often repeated than "A stitch in time saves nine." Yet a highly-trained worker is always of more value than a machine. He is worth taking care of.

CHAPTER V

THE PROBLEM OF LOST TIME

THERE is no subject which is of more vital interest to the employer of labour than that of "lost time." So far as the somewhat scanty investigations which have been carried out on the subject go it would appear that the evil is very great and widespread, and that its more obvious manifestations by no means exhaust the extent of its effects. There is lost time which can be reckoned in hours or even days. There is also lost time which is of the fabric of the day's work, so to speak, and which cannot be reckoned except by reference to the figures of output.

This latter is, perhaps, the more serious form, for it springs from causes which, in other directions, are working against the efficiency of the factory as a whole. They are physical causes and also mental causes. Most of them are remediable. On the other hand, employers seem to be slow to realize that a bad "atmosphere," in the psychical sense, is as dangerous to their pockets and general well-being as a slump in trade or a break-down of supply.

Some time ago the subject of lost time was

examined by a Government committee, who reported upon it at considerable length. They divided the conditions covered by the term as follows :

First, gross loss, actual absence from work for whole days or weeks, a degree of broken time which greatly interferes with the management of a factory.

Second, what is known as "loss of quarters," and particularly the "morning quarter"—Professor Loveday found in a prolonged investigation that the percentage of lost time before breakfast varied from 20 to 58 in a group of 17,000 persons working a normal day beginning at 6 A.M. or between 6 and 7 A.M. This loss was greatly in excess of any similar loss in factories which started work later than 6 A.M. It is added : "The magnitude of this common experience, the actual number of absences, the futility of working before having had a morning meal, and the waste of time incurred in two breaks daily have led many employers to the view that the two-break system might well be abolished."

Third, time lost in starting work even by a good time-keeper, and similarly time lost in ending work. In this connexion a statement of great interest was made by Dr. Vernon, in which he pointed out that when the motive power of the factory is electric the time occupied in starting work can be estimated from the circumstances that as the operatives got going, one after another, the power consumption steadily rises to a maximum, which is attained when all have begun. Allowances have to be made, of course, in cases where necessary tools must be collected before work. In one instance where men

were compared with women it was found that the latter wasted about seven minutes more in starting than did the former. On the other hand, the women finished more quickly than the men. It was found that both sets of operatives lost, on an average, about the same aggregate of time in starting and finishing during the course of the day—viz. thirty-four minutes. In another case the effect of the approach of the Easter holidays on a group of women workers was to prolong considerably the time taken to start work. For a few days after the holidays this effect persisted in an aggravated form. The comment is made : "There can be no necessity for the waste even of 25 minutes in starting and finishing work. Ten or 15 minutes should be ample allowance, and the 20 minutes thereby saved could be deducted from working hours without any reduction of output."

Fourth, loss due to unregulated rest pauses, absence of pauses, to long spells, and other faults in factory organization. It is contended that the custom for operatives to work five hours and then after an hour's meal interval go on working another spell of four and a half hours is a bad one. These spells are too long, and a rearrangement seems to be called for.

The causes of these various types of loss are very numerous, as will be readily understood, and it is difficult to disentangle them in some instances. One of them is certainly the presence in the ranks of labour of unfit men, whose maladies have not been recognized and so go untreated. These men are

often physically incapable of keeping good time, and their apparent bad example infects others, and lowers the whole tone of the factory. Again, the conditions in which the workers live is a matter of great importance. Dirty and inconvenient houses play a great part in wearing down that fitness of mind and body out of which alone good work proceeds. This matter is engaging general attention at present. In 1911 the Medical Officer of Health for the County of London stated that there were "throughout London about 1900 groups of three or more houses which were either insanitary or so congested, badly arranged, or badly situated that they required to be dealt with. The number of dwellings in these groups was 25,734, occupied, it was estimated, by about 195,000 persons."

On the other hand, an even more fruitful source of lost time is the difficulty of transport to and from work. This greatly complicates the housing question, because if the bad old houses surrounding the factories are to be got rid of the population will require to come to work over considerable distances. The workers themselves are very reluctant to go far afield because this means an earlier start in the morning and a later return at night; moreover, travelling is expensive. Local authorities, too, are reluctant to displace residents in their districts unless it be possible to re-house them in the neighbourhood.

It is clear that there is here a dilemma which will be difficult to solve. The employer, however, will assuredly serve his own best interest if he makes war

upon the dirty house. Employees who come to him fresh and cheerful in the morning, provided they have not too far to come, will spare his time and afford him a service which the tired, the dirty, and the dispirited cannot render. Another fruitful cause of lost time is industrial fatigue. With this we have already dealt.

Reviewing all these causes, the expert committee were satisfied that "the loss of time directly and indirectly due to fatigue and ill-health is substantial, and is as a rule greatly under-estimated." On the other hand, "there would seem to be a tendency to over-estimate that due to slackness, laziness, or wilful idling."

The cure for loss of time cannot, therefore, be of the nature of a nostrum. It must be as manifold as the phases of our complex social system. Shorter hours, for example, will help; so will improved conditions and circumstances of labour, including a high standard of efficiency; so will better housing and more rapid transport; so will good health.

These things can only arrive slowly. Meanwhile employers would be well advised to find out, each man for himself, just how much time is being lost in the business or factory they preside over. Careful records should be kept of

(*a*) Lost and broken time.

(*b*) Absence or broken time due to sickness.

(*c*) Output per worker per hour so far as this can be ascertained.

Lost time, after all, is one of the diseases of industrial life. Unless the disease is diagnosed in any

particular business no steps can be taken to cure it. When its presence has been recognized the employer will be in a position to look for immediate causes and to think out special remedies suitable to his own case.

This brings us to the obverse of the problem—the kind of incentives to work which the employer may place before his workpeople. The committee we have referred to placed the health of the worker before all other considerations, even as an incentive to good output, and this finding was based upon very careful and searching tests and experiments. They urge the employer to realize that everything he can do to increase the well-being and comfort of his men and women will in the end prove a source of profit to himself.

Thus, they urge the necessity of good lighting on scientific principles, effective ventilation, sufficient heating, cleanliness, rest rooms, proper canteen accommodation, and measures of protection against accidents and industrial diseases. They would further extend the care to the homes of the workpeople in so far as this can be done.

Only second to the health of the workpeople they place as an incentive to output a properly organized factory in which the rate of machinery and other matters have been carefully considered and in which good order and discipline are enjoined. The hours of work must be such as to avoid fatigue. This view has been strongly insisted upon by other observers. Professor Loveday wrote: "When once industrial life has been entered upon the ordered and systematic routine of a modern factory is a direct stimulus during every 24 hours to the rhythm of activity and rest; the better the organization and the better the hygienic environment, the greater is the stimulus to activity."

Finally, there is the wage as an incentive to effort and to the avoidance of loss of time. It is a matter of first importance that whatever method of payment may be adopted this method should be clearly and thoroughly understood by every employee. Employers often fail to realize how simple are the ideas of many of those who work under them and how violently a sense of injustice reacts upon a simple mind. Misunderstanding is the fruitful mother of this sense of injustice, and once a wrong impression has got abroad it is very difficult to eradicate. The effect of it will soon be evident in a lack of enthusiasm or even in positive ill-will, and these, again, will rapidly translate themselves into lost time and diminished output. Every care, therefore, should be exercised to explain the system of payment to each employed person.

As a general rule piece-rates appear to exercise a better effect than time wages, and time wages with a bonus than a flat time rate. Piece-work, on the other hand, has its dangers, for it is apt to lead to overwork and so to work which is of inferior type. This can only be met by securing that employees understand how greatly their own success and prosperity depend on the care they take of their health. Many far-seeing employers encourage the delivery of health lectures to their workpeople, and

even go out of their way to arrange for these to attend them. They are rewarded when it becomes a fixed principle of the operatives they control that a sick man is a danger to his fellows.

Once again we perceive how real is the community of interest between employer and employed, or, if you will, between capital and labour, and how false and unenlightened the idea that these two are at war with one another. Every advance in knowledge, every improvement in scientific technique which makes the lot of the worker easier or affords him a better return for his labour, at once puts money into the pocket of the master. Every retrograde step, no matter how apparently successful at the moment, robs both.

CHAPTER VI

THE LOST WORKER

EVERY industry has its "lost workers"—the men and women who disappear. There is little information concerning these, yet it is really by them that we must test our new science of Industrial Hygiene, our measures for the prevention of disease, and our plans for the future, as we shall hope to show.

That the subject has not been entirely neglected is due in no small measure to the labours of Captain Greenwood, who at the request of the Committee on the Health of Munition Workers instituted an inquiry into the fate of a number of "lost workers" among women employed in munition factories. His investigation was carried on in sixteen factories or sections of factories employing in all some 40,000 women workers.

The immediate cause of the research was the fact that at a moment when every worker was a national asset the disappearance of workers became a national danger. Although the majority of operations carried out in munition factories did not require a

high degree of manipulative dexterity, yet most of these led, when often repeated, to an increased precision of work, and therefore to increased rapidity of output. In the manufacture of cartridge cases, for example, a woman did not attain her maximum of output till she had been engaged during some weeks on her task. It followed that a factory at which the operators were constantly leaving and being replaced could not attain the same level of output as one with a more or less stationary population.

This truth holds good in peace time, though in a somewhat modified form, for the "lost worker" represents, as we have pointed out before, time and money spent in promoting his training. Under war conditions there was, of course, a constant and urgent demand for labour. As a result, discontinuity, due to seasonal and other variations, was practically non-existent. On the other hand, the calls of the war certainly encouraged workers to serve who were not fitted to do so, or who were discontented in their own occupations. These latter had no longer the fear of unemployment to keep them in tasks they did not enjoy. It will therefore be seen that Captain Greenwood's findings, while they apply in a broad sense to our present industrial conditions, require to be understood as war-time material and allowed for accordingly.

He points out that he had no earlier work to guide him in his search, for no similar inquiry had been attempted in this country. In the United States,

however, certain investigations had been made by Mr. Joseph H. Willits in Philadelphia and published under the title of *Steadying Employment*, May 1916. One example of the results of this work may be quoted :

> A particular shop in a carpet mill was selected for intensive study. The dates of engagement and discharge of the employees were tabulated for the period 1907–15. As a result it appeared that 48 per cent of the men and 38 per cent of the women remained in the service of the firm less than 10 weeks.

A wider and less detailed study was made by Mr. Alexander, of the General Electric Company, of a large number of factories of all sizes in the United States and Europe. From the figures collected the fact emerged that on January 1, 1912, 38,668 persons were employed in the factories, and on December 31, 46,796, or an increase of 8128. During the same period, one year, 44,365 persons had been engaged. So that 36,237 had dropped out of employment. That is to say that $5\frac{1}{2}$ as many people had to be engaged as constituted the actual increase in the number employed at the end of the period.

Put in tabular form this gives :

At work January 1	38,668
Engaged during year	44,365
Total	83,033
At work December 31 . . .	46,796
Increase at work	8,128
Lost workers	36,237

Captain Greenwood's figures from a large munition factory are as follows :

Month.	No. employed.	No. started.	No. left for various reasons.	No. left, no reason.	No. employed at end of month.
June . . .	4340	622	138	253	4571
July . . .	4571	695	48	87	5131
August . . .	5131	464	67	220	5308
September . .	5308	578	174	45	5667
October . . .	5667	1054	236	248	6237

Thus 2791 women were engaged and 1125 left during the four months July-October. The number of engagements was thus 167·5 per cent of the net increase in the time. Further, during these four months, together with the previous month, the firm lost 1516 women workers. In only 663 of these cases, or 43·7 per cent, was the cause of leaving known to the firm. The others had simply vanished.

A second set of facts comes from a cordite department of a large munition factory. In this, during the twelve months ended August 28, 1916, an increase of 624 workers resulted from 1031 new engagements among men. An increase of 914 was obtained in the same factory from 1527 new engagements among women—percentages of 165 and 167 respectively, on the whole rather favourable figures.

More detailed investigation was possible at a factory organized in two main departments—one producing cases and bullets and the other carrying out cartridge and grenade filling operations. Records had been kept by the firm of name, age, previous occupation, character, and reason for leaving, which

permitted data to be collected. Captain Greenwood classified the causes of leaving as follows :

(1) Those who left on account of ill-health.

(2) Those who left for some sufficient reason other than that of health—*e.g.* :

(*a*) Girls who left to get married.

(*b*) Girls moving from the district.

(*c*) Girls required at home on account of illness or to keep house.

(*d*) Girls who found the wage earned insufficient.

(*e*) Girls discharged because they were unsuitable or the factory was slack.

(*f*) Girls considered by the factory surgeon to be physically unfit, though not complaining of illness.

(3) Those who left for no reason or for an insufficient one—*e.g.* :

(*a*) Girls discharged for misconduct.

(*b*) Girls leaving for other employment without assigned reason.

(*c*) Girls wanting a change or dissatisfied.

The great majority in the last category gave no reason at all. Analysis showed that of 1000 girls entering the factory during the war period 132 did not outstay the second month ; even if there had been no loss from sickness or other reasonable cause 1000 would still have been reduced by 10 per cent. This 10 per cent were employed for so short a period that little useful service was rendered. They left as was ascertained from mere caprice, unwillingness to submit to discipline, love of change, misfits as between task and employee.

These figures show that at a factory of high standing, thoroughly familiar with the industry,

since it was running in peace time, the absolute loss of workers was serious. This factory was compared with another in the open country, six miles by rail from the nearest town and still farther from any large city. The workers travelled at least six miles to and fro.

The loss in this second factory was little more than a third of that in the other. In searching for a cause of this it was noted that the factory with the smaller number of "lost workers" made most ample provision for the care of the workers' health and comfort. In these respects, indeed, it was "probably unsurpassed by any other in the country." Any woman absent for more than two days without communicating with the management was automatically discharged, but in practice all these cases were followed up and the sick visited. Still another factory was examined. It was situated in a Midland industrial city and was found to lie between the foregoing in the matter of losses.

The inquiry next concerned itself with heavier work. It was found that the rates of loss at ages above 22 were significantly greater than for girls between 18 and 22. Captain Greenwood writes:

> It appears that the unusually heavy losses are seriously contributed to by ill-health and other sufficient causes—causes of leaving for which the employees are not themselves responsible.

A heavy type of occupation is thus apparently unsuited to women workers over 22 years, who are indeed thriftlessly employed on it. For

in this occupation the "survival rates" diminish with age, a state of matters not met with in lighter work. The older women, it must be remembered, are often married. The double handicap of age and home duties is apparently sufficient to diminish resisting power when heavy work is taken up.

As regards the effect of sickness it is interesting to note that "out of nearly 37,000 women under observation for at least a month, illness or medical unfitness is given as the cause of leaving nearly 1651 times." The losses from ill-health are practically the same at all ages in light factories, while they increase after the age of 22 in the heavy factories. Under 23, girls have fewer sickness losses in the heavy than in the light factories.

It will thus be seen that the lost worker, and especially perhaps the lost woman worker, is a big problem of industry, the solution of which is far from complete. We require further data and further research, for until the causes of the loss are fully understood no cures can be applied. Captain Greenwood's investigations have touched only a portion of the subject. Yet they have revealed one important fact. He declares:

> Of a total number of about 11,000 women who left, about 6700 gave no reason for doing so; this is not a satisfactory state of affairs. There is no panacea for the disease but there is one promising remedy. This is organized welfare work. It has already been suggested that in factories where there are organized welfare departments the wastage unaccounted for is below the average.

Thus, intelligent and sympathetic following up of absentees and the visiting of the sick is likely to produce good results, and certainly, where a factory loses more than 20 per cent of its entrants, an investigation on those lines should at once be carried out. Further loss can certainly be prevented by judicious selection of entrants, both by medical men and by the employers themselves. To set a sick man or woman to an exacting task is to invite failure and to inflict great damage. To set a man or woman of one kind of physique or temperament to work demanding other kinds is to display mere stupidity.

Finally, the human element is at play and must be taken into consideration. The heavy "losses" of some firms can be traced to the employment of ill-natured overseers and managers with whom no one can work in comfort. A change in this direction may mean a stoppage of the trouble, and so a substantial increase in the annual output. From my point of view it is clear that the employer who considers his "human machinery," who cares for it, and watches over its welfare, is he who considers best his own personal interests.

CHAPTER VII

WOMEN IN INDUSTRY

THE work already accomplished on this subject is, at the best, somewhat fragmentary. Such as it is, however, it reveals the very large amount of ill-health which exists among women workers, and the consequent necessity of supervision and of selection. This is very clearly brought out in the following tables, which show the chief defects noted in a series of factories among women workers:

	Factory A.	Factory B.	Factory C.
No. examined	193	264	116
Percentage of Defects	100	100	100
Digestive System:			
Indigestion, pain, etc.	23	15·5	25·5
Constipation	14·5	7	9·5
Teeth:			
Several carious	31	26·5	20
Oral Sepsis	8	10·5	13·5
Artificial	32	15·5	20·5
Nervous System:			
Tired, nervous, irritable	30	13	20
Headache (frequent)	42	13·5	33·5
Anæmia	13	12	23
Aching and Swollen Feet	10	5·5	4
Muscular Pains (rheumatism)	14·5	8	20
Nose and Throat troubles	5·7	2	3·5
Eye Strain	6	2·5	22·5

The results speak for themselves. The inquiry was voluntary and was undertaken during the war at munition factories. Some of the conditions were such as to prevent the worker from giving useful service, for example, loss of appetite and pain after food. At one factory (not included in the table) digestive disturbances affected 21 out of 67 employees. This was traced to bad cooking and catering. Bread and butter and tea formed far too large a part of the dietary. At another factory 41 girls were noted as being underfed, and there were 43 cases of indigestion among 114 examined. This was not due to bad teeth, but seems to have occurred because a long bicycle ride had to be taken just after meals to get to work. Cooking, too, was deficient in quality.

Nevertheless, bad teeth were common enough. The workers seem to have believed that these did not much affect their digestion, but in view of exact scientific knowledge on this subject such a view cannot be accepted. There can be no doubt that the opinion of the examining physician is sound—that bad teeth "are bound to affect the health adversely and are, indeed, responsible for malaise and headaches with which the workers do not associate them." Such a report as the following is a disgrace to modern civilization and, moreover, reveals a great lack of business acumen on the part of both employer and employed:

> The teeth were usually extremely bad, dental hygiene seemed unknown, and pyorrhœa occurred in most of the women over 30 years of age. Considerable reluctance was shown at the prospect of a visit to the dentist, and conservative treatment was rarely sought in time even by young girls of otherwise good appearance. There was a general impression that stopping always hurt more than having a tooth out, and as a result no treatment was sought.

We shall have occasion to return to the subject of dental care in industry. It is enough at present to note that among young women workers, that is to say, among the mothers of future generations of workers, dental decay is prevalent.

Headache was another frequent complaint. It was found to be due in some cases to mere tiredness, in others to noise in the factory, bad conditions of travel, insufficient fresh air and exercise. In still another group of cases bad teeth, bad digestion, and anæmia were the causes. At one factory, badly built and crowded with machines, no fewer than 40 out of 67 girls complained of headache. This they attributed to the noise and the long periods during which they had to stand on their feet.

The prevalence of swollen and aching feet was commented on. This most disabling condition appeared to be due to the circumstances of work and especially the nature of the floor and the lack of provision of seats. At one factory where the heating was defective and the floors were uneven and wet, muscular pains and swollen, aching feet were common. At another factory varicose veins seemed to be common among the older workers and to be associated with foot trouble. The floors were not satisfactory. In addition to these troubles a number

of ailments peculiar to women were met with. No doctor had been consulted in most cases, and thus disabling diseases were going on unchecked, and were literally sapping away the strength which should have been available for work and for the future.

The modern employer who engages many women workers cannot, it may be supposed, view such a state of matters as exists at present without misgiving. As soon as he recognizes how many of the women engaged in industry are unfit to a greater or less degree he will perceive that their work is bound to be as unfit as themselves. It is thus to his interest that welfare work among women should be begun at once, and that medical advice and help should be available. A bad floor may, for example, conceivably save the price of a good one. And so long as the evil effects of a bad floor are not understood this may seem to be a justifiable economy. But when these evil effects have been made manifest —the sore feet, the pains, the headaches—and when the high cost to the employer involved in the effects has been set out, the " economy " will appear rather as a ruinous waste. The following percentage table showing the results obtained at eight different factories deserves close and anxious consideration :

PERCENTAGE OF TABLE DEFECTS

Percentage of Defects noted.	Digestive Defects.	Teeth (including artificial).	Nervous Defects.	Headache.	Anæmia.	Sore Feet.	Nose and Throat.	Eye.
100	86	59·5	20	28·5	20	12·5	7·5	8·5

Most of these defects could have been prevented by the exercise of a little care.

This becomes more evident when another aspect of the subject is taken into consideration—that of industrial fatigue. In earlier chapters we have discussed the bearing of this insidious disability on output, and shown, on scientific evidence, that there exists no greater enemy of output and efficiency. In the eight factories mentioned above an estimate of industrial fatigue was made, and the girls were divided into three classes, those in good health, those showing some sign of fatigue or ill-health, and those showing marked signs of fatigue or ill-health. The following table shows the results :

	Healthy.	Slight Fatigue.	Marked Fatigue.
	Per cent.	Per cent.	Per cent.
Factory A . .	59·9	36·2	6·7
„ B . .	75·3	20·07	4·5
„ C . .	54·3	39·6	6·03
„ D . .	71·3	26·1	2·5
„ E . .	38·6	57·2	4·02
„ F . .	61·6	26·02	12·3
„ G . .	52·2	44·7	2·7
„ H . .	44·7	45·6	9·6

It needs no emphasizing that the lot of an employer controlling Factory D, with 71·3 per cent healthy workers and 26·1 slightly fatigued, and only 2·5 markedly fatigued, must be a happier one than that of an employer controlling Factory E, with respectively 38·6 healthy, 57·2 slightly fatigued,

and 4·02 markedly fatigued. The percentage results for the whole eight factories were :

Healthy.	Slight Fatigue.	Marked Fatigue.
58·4	35·8	5·5

The causes of the fatigue were ascertained as far as possible, and were put down to " heavy work, especially when associated with long hours, age and general unsuitability for particular work, length of service, insufficient attention to 'welfare' inside the factory, home duties, mental anxiety, transit, dietary, etc." The nature of the work a woman may properly be asked to perform is a subject which demands very careful consideration.

In the inquiry we have described it was established that considerable fatigue was shown by girls under 18 who were working long hours in unsuitable conditions. Improving these conditions at once reduced the extent of the fatigue, and so, of course, increased the value of the work done. From the national point of view the induction of fatigue in girls of this age is a crime. It means a lowering of vitality which may never be adequately compensated for and which may therefore affect the welfare and the working capacity of the next generation.

Length of service in the case of women, as in the case of men, renders the healthy more fit for their work—because they have become accustomed to it, but more and more adds to the burden of the

unfit. Thus the following table compiled from one factory during war conditions shows how many girls displaying slight signs of fatigue in 1916 were displaying marked signs in 1917. Those showing no signs (the healthy) had meantime increased in number :

	January 1916.	July 1916.	October 1916.
	Per cent.	Per cent.	Per cent.
Healthy . . .	38	52·6	56
Slight Fatigue . .	49	33·7	22
Marked Fatigue .	13	13·7	22

Thus at first a number of the girls grew more expert and so felt fatigue less—and these moved up from the second to the first class. Then, after a year of work, another group which had shown only slight signs of fatigue move downwards from the second to the third class.

Insufficient attention to welfare among women workers is thus a serious ill which is costly to the nation and to industry and which demands both prevention and cure. This is a very complicated problem, because it involves consideration of the amount of work, if any, which married women and young mothers should be allowed by the State to carry on. It involves, too, an examination of the breaks in work which must occur at those periods when the duties of motherhood demand full attention. The matter will have to be faced at an early moment, because the war has driven so many women into industry that a sudden crisis has been reached.

The case for an extension of welfare work to women is thus a very sound one. Those firms who have recognized the need and acted accordingly are unanimous in acclaiming the advantage of the steps taken. Those firms who lag behind are standing in their own light. The day is certainly at hand when legislation on this subject will be undertaken on a large and comprehensive scale.

CHAPTER VIII

JUVENILE EMPLOYMENT

THE whole position of juvenile employment in this country is about to undergo a change as the result of the new Education Act. It is therefore important that employers should understand what proposals are being made and in what manner they can assist the authorities in caring for the health of the youth of the nation.

In his report on the School Medical Service during 1918, Sir George Newman, the Chief Medical Officer to the Board of Education, and also the Chief Medical Officer to the Ministry of Health, devoted a special section to the question of juvenile employment. Under the Children's Act of 1903 as amended by the Education Act of 1918 it is, he pointed out, provided that children under 12 years of age shall not be employed at all; children under 14 years of age shall not be employed in street trading; children over 12 years of age may not be employed (1) on Sundays, (2) on schooldays before the close of school hours, and (3) on any day before 6 A.M. or after 8 P.M.

Sir George Newman recommended that the school medical officer should report periodically upon the employment of all children of school age and its effect on their health ; should examine annually all " leavers " as required by the Code and report on their fitness for employment ; should examine employed children at once ; and later, from time to time, re-examine them, certifying to the Authority if and when the employment is injurious or prejudicial to the health or physical development of the child ; should co-operate with the certifying factory surgeon of the district in selecting children for factory work ; should furnish, on application, the welfare supervisor of factories and workshops where the child is employed with the latest school medical reports on the child's physique ; finally, should co-operate closely and continuously with the Juvenile Employment Committee or with the Labour Exchanges.

It will be seen that this programme, if carried out, will afford an employer a means of selecting suitable young people for his works, and will relieve him to some extent of the responsibility of engaging those who are unfit for the labour they may wish to take up.

In 1917 the Minister of Labour addressed to the principal employers' associations and trade unions a letter informing them that the War Cabinet had approved the principles of the report on Joint Standing Industrial Councils which were issued by the Reconstruction Committee appointed to consider the relations between employer and employed. A

number of these councils have now been formed. Almost invariably there has been included in the constitution of these councils a clause dealing with the health conditions obtaining in the industry. These joint industrial councils may therefore be expected to assist in looking after the health of the young people employed in the industries over which they preside. Sir George Newman afforded an outline of what he regarded as an enlightened arrangement for the care of young employees, and declared that the more progressive firms are already in possession of the facilities :

1. A medical officer should be appointed by the firm and may be whole-time. He has now in some cases a set of rooms at his disposal—a consulting-room, a massage-room, a rest-room, a dispensing and a dental surgery. Advice is obtained free by any one in the firm's employment. In a number of cases treatment and medicine are also free. Letters admitting to hospital are available, and visits are paid to homes within a certain radius.

2. Employees should be inspected on entry by the firm's own medical officer. A dossier is opened in some cases in which a health-card is kept. The examination includes inspection for cleanliness, teeth, eyesight, hearing, throat, glands, lungs, heart, anæmia, height and weight. Medical defects involving rejection include heart disease, lung disease, marked deformity, and may include educational retardation and dental defect. Skin defects of the hands may involve postponement of employment till they are cured.

3. Men and women welfare supervisors, to undertake the care of all matters relating to the health of the workers, should be appointed. A certificated nurse is often engaged for this work, and her duties include attention to patients coming to the dispensary and the visiting of the homes of absentees and reporting cases of illness to the medical officer. They also include inspection of hair, skin, and hands of girl workers. A rest-room is often provided.

4. Full-time or part-time dentists have been appointed to inspect all entrants, to treat juvenile employees by conservative methods, and to provide artificial dentures where necessary. In some cases the firm pays for this treatment up to 21 years of age; in other cases dentures are provided at cost price.

5. Baths, with hot and cold water, dressing cubicles, towels, and so on, are frequently provided free of charge.

6. Physical training should be encouraged. Athletic clubs are in existence in many factories and sports grounds have been provided. Swimming-bath and gymnasia are also part of the equipment laid out by some employers.

7. Attendance at continuation classes is now made compulsory by some employers for workers under the age of 18 years. These classes, as a rule, occupy three hours per week for three years.

8. Some firms have instituted a second medical examination six months after admission to their employment. This second examination sometimes has the result of changing the work of the employee.

9. First aid.

10. Convalescent-homes, holiday-homes, and camps.

11. Remedial exercises are now much used and should be encouraged. Some firms provide a physical culture class for girls needing special attention. In other cases remedial exercises are given in the massage-room of the medical department under the supervision of the woman medical officer.

12. Provision of meals.

Medical inspections have recently been carried out at the London Centre for Juvenile Unemployment, and a valuable report has been issued by Dr. Hamer, the Medical Officer to the London County Council. Some 673 boys and 45 girls, between 14 and 18 years of age, obtaining the unemployment donation were examined and it was found that 318 boys (47 per cent) and 16 girls (35 per cent) were in need of treatment.

The condition of the clothing of the boys was generally found to be better than that of boys just leaving school, only 2·5 per cent being classed as poor. The state of cleanliness, especially as regards "heads," was good, 99 per cent having heads completely free of vermin. The nutrition of the boys presented greater variation than that of boys leaving school. Forty-one per cent were classed as "excellent," as against 25·2 of leaving schoolboys. On the other hand, 49·3 per cent were "normal," as compared with 69·5 per cent, and 9·7 per cent were "below normal," as compared with 5·3 per cent.

The condition of the teeth was distinctly worse

than that of boys leaving school. It is noted, however, that these boys left school when the Council's arrangements for dental treatment were less fully developed than is now the case. Nose and throat troubles were fairly prevalent, for 4·7 per cent of the lads had enlarged tonsils ; on the other hand, only ·7 per cent had adenoids. But these conditions tend to disappear during adolescence.

Fifty-eight per cent of the boys had normal vision, but 25·7 per cent had a high degree of visual defect. The figures for boys leaving school were respectively 57·6 per cent and 21·7 per cent. Only 1 per cent had ear disease. Five per cent stammered, as compared with 1 per cent leaving school. The percentage of cases of heart disease was identical in the two groups—viz. 3·4 per cent, but anæmia was found in a less number of cases in these lads than in the schoolboys. Lung diseases other than consumption were rare. Consumption was present in ·3 per cent, compared with ·2 per cent of boys leaving school. For other forms of tubercle the figures were ·7 per cent and ·2 per cent respectively. The remains of rickety deformities discovered were 4·6 per cent, as against 1·8 per cent in boys leaving school. For other types of deformities the figures were 5·5 per cent and 1·8 per cent respectively.

We have given this report in some detail because it opens some important questions regarding the effects of employment on the young boy. This is most striking in the case of rickets and other deformities, which were much more prevalent in the older boys than in the boys leaving school. On the

other hand, heart trouble had not increased after school life. It is argued that if employment was proving too strenuous the heart would have given way first and that consequently the increase of deformity was not due to employment, but is rather to be ascribed to the fact that a progressive tendency was present in certain of the lads. In the same way the relationship between the onset of varicose veins and employment requires further study, for it is by no means certain that this condition is to be ascribed to the work at all.

The final recommendations made are that there should be definite co-operation between the industrial bodies, the local education authority, the sanitary authority, the certifying factory surgeon, and the employer. The records of a boy's school medical history are available, and should be passed on, when he enters employment, to the certifying factory surgeon. The latter has his duty of acceptance, postponement, or rejection in regard to the lad's employment. The employer is responsible as regards the working conditions involved in the employment.

Secondly, the selection of the young employee "from the point of view of physical fitness for factory conditions is a matter of supreme importance." On it may depend the necessity for the adaptation of the work to the workers' condition. There is need, too, for more adequate arrangements for the detection and treatment of disease, since impaired health means impaired work and reduced output. The factory must be hygienic and facilities for physical training must be promoted.

CHAPTER IX

THE PRICE OF DISEASE

THE industrial revolution in the United Kingdom took men, women, and children from the fields to the towns, from the chamber-workshop to the mill, from an evil environment to a worse. It turned the discomforts and limitations of the poor into a rigid system, a system which left indelible marks on the physique of the people.

The first signs of reaction came in the early part of the nineteenth century, when the State found that its children were being ruined in body and mind by the conditions and circumstances of their employment.

Official reports in 1816, 1819, and 1832 and subsequent years furnish overwhelming medical evidence of the gravity of the physical injury due to the premature, prolonged, or unsuitable employment of children. There is now a century of proof.

Nor was such employment affecting children only. "We manufacturers," wrote Robert Owen, "are always perfecting our dead machinery, but of our living machinery we take no care." Another writer

declared that "to use up or damage its women by setting them to hard wage labour in mill and workshop is probably the greatest human waste a nation can practise or permit." The result of these warnings was that steps were taken to find out the effects of occupations of various kinds on the men and women engaged in them.

It then became clear that every industry in greater or less degree affected the death rate, or, in other words, that, of itself, without adequate precaution or safeguard, each trade added to the loss of human life and health, and so to the weakness of the nation. Tatham showed, and the chief medical officer of the Ministry of Health quotes him as an authority, that if the comparative mortality figure for the agricultural labourer be 602, that for the shoemaker is 920, for the hairdresser 1099, for the chimney sweep 1311, for the glass maker 1487, for the lead worker 1783, and for the file maker 1810. The contrast is even more marked for sickness, disablement, and accident.

If we are to judge by the attitude of its Chief Medical Officer the Ministry of Health will devote its attention to the following points :

(*a*) The careful selection of workers on engagement, and periodical medical supervision (including observation as to output, lost time, sickness, physiological requirements, etc.).

(*b*) The hours of employment—shifts, breaks, spells, pauses, holidays, Sunday work, night work, overtime.

(*c*) The factory or workshop environment—design, structure, sanitation, cleanliness, heating, temperature,

ventilation, lighting, sanitary accommodation, washing facilities, cloakrooms, seats, rest-room, surgeries.

(*d*) The personal well-being of the worker—the industrial employment of women, incentive, food supply, and drinking water, canteens, protective clothing, lifting weights, welfare conditions, rest, recreation.

(*e*) The effect of occupation on health—fatigue (due to excess in duration of labour, specialization, repetition, strain or speed), sickness, injuries, accidents, industrial disease (poisoning by lead, phosphorus, arsenic, mercury, anthrax, dust, fumes).

These matters, it is pointed out, concern 130,000 workshops and 150,000 factories in which 12,000,000 people spend a third of their lives. "Whatever was the case before 1914, the experience of the war has demonstrated beyond all question that industrial hygiene forms an integral part of the practice of preventive medicine."

Nor, indeed, does the State lack financial and economic support for the policy which it is about to adopt on humanitarian lines. The figures published of the economic loss from sickness and disability among the working population are appalling. The estimated number of insured persons in England entitled to medical benefit for 1914 was approximately 10,300,000. Of this number approximately 5,800,000 applied for and received medical attention, being 56 per cent of the whole number entitled to treatment. In other words, over half the total insured population in that last normal year before the war came under review by the Insurance Practitioners within the twelve months. In certain

industrial practices the proportion claiming and receiving treatment was as high as 70, 75, or even 80 per cent of those eligible.

When we come to reckon this in terms of time lost from employment we get a glimpse of the national loss entailed. For the year 1916 (the latest for which figures are available) the amount paid in sickness benefit in England only for men was £3,409,914, and for disablement benefit £587,671. Taking the maximum rate of sickness benefit (10s. a week) and of disablement benefit (5s. a week) these figures represent 6,819,828 weeks' sickness and under disablement benefit 2,350,684, a total of 9,170,512 weeks. For women the figures are not less alarming. They total 3,473,424 weeks' sickness. Thus at least 12,643,936 weeks' work were lost during the year 1916, or a period equal to 243,000 years.

The following table gives a summary of the expenditure of approved societies (England and Wales) on sickness and disablement benefits in the years 1914, 1915, and 1916:

Year.	Sickness Benefit.		Disablement Benefit.	
	Men.	Women.	Men.	Women.
	£	£	£	£
1914 . . .	4,322,694	1,795,651	125,608	37,810
1915 . . .	3,949,503	1,389,653	498,332	206,807
1916 . . .	3,701,427	1,193,944	640,395	306,530
Total for three years . .	11,973,624	4,379,248	1,264,335	551,147
Average per annum . .	3,991,208	1,459,749	421,445	183,716

The amounts per annum given in the above table represent a minimum average of 14,295,724 weeks of sickness (at 10s. per week for men, and 7s. 6d. for women, and 5s. disablement for men and women), or a period of upwards of 270,000 years. "*This is equivalent to a loss to the nation every year of the work of upwards of* 270,000 *persons.* Moreover, no account is taken of the labour and expense involved in the care, nourishment, and treatment of these sick persons during the 14,000,000 weeks of their incapacitation."

This mass of sickness is practically confined to the workers of the country. A great part of it is preventible and the prevention depends in large measure on industrial hygiene—that is to say, on good environment during the working day. It is only necessary to think of tuberculosis to realize that infection must often be spread by means of unsuitable surroundings, lack of inspection, ventilation, and so on. Indeed, it was found that certain communicable diseases ranked high in the list of those sending insured persons to consult their doctors. Thus, bronchitis, bronchial catarrhs, nasal catarrhs, and colds accounted for a proportion of 181·3 per 1000 cases; pneumonia and allied conditions for 69·2; skin diseases for 47·1; abscesses and boils for 49·1. Injuries and accidents claimed 60·7, and digestive troubles—the origin of which is too often to be found in badly planned meal hours and unsatisfactory works' canteens—for 143·1.

CHAPTER X

WASTE IN MOVEMENT

THERE has never been a time in which waste, and especially industrial waste, was so inexcusable. Economy is not only a virtue, it is a necessity. All that is superfluous must go.

It is for this reason that any methods which have as their object the recovery of lost time or lost effort deserve the careful consideration of employers. And when it can be shown that the method has already, in other hands, yielded valuable, nay rich, results, the importance attaching to it cannot be exaggerated. For this reason the study of motion in industrial activity is bound to attract great attention during the coming years.

This study has been carried a step farther by the publication of a report of the Industrial Fatigue Research Board on *Improved Methods in an Iron Foundry.* This report, curiously enough, seems to have been issued without knowledge of the remarkable work of Taylor and his disciples, which has earned for this branch of industrial medicine the title of "Taylorism." In the circumstances,

it will be helpful to explain the progress which has already been made.

It was observed long ago that the amount of effort usually expended in the carrying out of any given action can be greatly reduced if a little care is exercised. Every man, left to himself, wastes his energy. He puts too much force into his movements, he carries out unnecessary movements, he calls into play groups of muscles which need not be used, and so on. This he tends to do to a greater extent when he is learning a new operation, and to a less extent when he has become proficient—just as the child writes at first with all its muscles tense and its tongue out, but latterly with only a small action of the wrist.

Now this unnecessary movement, this reduplication of movement represents an enormous body of lost time and lost effort, and so of lost output—a loss, indeed, very comparable to that experienced in the combustion of fuels. It was the object of Taylor and others to recover this loss, to eliminate the superfluous movements and then by a process of re-education to ensure that workers should follow a standard in which waste and loss would be reduced to the lowest possible proportions.

The results achieved surprised even their producers, and the study of movement in industry became a recognized method. Its objects were two-fold—the determination of what was useless and the determination of the most efficient method of using the useful. In other words, accurate measurement of each of the "movements" of industry

became essential. It was necessary, for example, to watch the bricklayer at work, to observe his methods, to see whether or not he was expending more movement on each operation of his calling than was essential to its performance. The same thing applied to other trades.

A beginning was made with a stop-watch, but it was found that this method was not accurate because there was the personality of the man with the watch to be allowed for. So photography, and later the cinematograph, was called into play. But it was essential to have a record not only of movement, but also of the timing of movement if the work was to be of any real value. Consequently a machine called a microchronometer, capable of recording down to a millionth part of an hour, was included in the picture, with, beside it, a good reliable clock to serve as a check on its readings. Later, the worker and the timepiece were placed in front of a cross-sectioned background so that the motions and movements might be more exactly located in space.

Thus in the same photographic film there was an exact record of the movements made, an exact timing of them, a check upon this timing, and a means of locating them. The excellent commercial results achieved prompted further progress in the study, for in one shop alone, where 18 to 20 textile machines had been assembled, it was found possible, after study, to assemble 66. The saving was the direct result of the micromotion study combined with the improved placement or assignment of the

workers to the work, and the improved surroundings, equipment, and tools with which the work was done.

It was necessary, however, not only to eliminate needless motion, but also to teach beginners how to avoid it.

The " average engineer," wrote Frank and Lilian Galbreth in a paper presented at the second Pan-American Congress at Washington in January 1916, " who becomes, through his training and the necessities of his work, a good visualizer, even though he is not one by nature, often fails to realize the small capacity for visualization possessed by the average person. A long experience in teaching in the industries made this fact impressive and led to the invention of the cyclegraph, and later the chronocyclegraph method of recording, in order to aid the non-visualizing worker to grasp motion economy easily."

The cyclegraph consists of a small electric light which is attached to the hand or other moving part of the worker's body. In this way it is possible to obtain a line of light on a photographic plate, which line represents the course of the movement. The time occupied is supplied by a clever device whereby interruptions are introduced into the line. The lamp on the man's hand is caused to flicker, so that instead of a steady line on the plate a dotted line appears. Each dot represents a second or other unit of time. In addition, it has been found possible to cause the lamp to extinguish slowly and to light again quickly at each interruption, so that each of

the dots on the plate is shaped like an arrow-head. This affords an indication of the direction of the movement.

A stereoscopic camera is used in examining the photograph thus obtained, so that one is enabled to see the line of movement in three dimensions. Finally, it has been found possible to attach a number of lights to the same man, and so to record not only motions of the hand, but also of the feet and other parts of the body.

The apparatus used has been simplified, so that it is not expensive. The records possess a permanent value and are of great use for teaching pupils standardized movements. To this end the pupil not only studies the photograph of the movement, he is also taught to make an exact model of the line of movement out of wire suitably bent and twisted. The excellent results obtained by the making and use of these models are thus described:

> The motion models not only enable one to visualize the non-material and intangible motion path, but also make possible the teaching of motions through the eye or through the touch, thus appealing to vision, touch, and the kinesthetic sensations. . . . Through the study of the motion path and through a comparison of such graphs or models, showing the paths of different operators doing the same kind of work, it is possible to deduce the most efficient method and to make this a standard. Moreover, each standard motion path is a help towards deducing other standard motion paths. Through an intensive study of motion paths followed in doing different kinds of work efficiently, there has come a

recognition of the indications of an efficient motion, its smoothness, its lack of hesitation, its regular normal acceleration and retardation, and its use of habit.

Inasmuch as it has been found that the same motions are used in carrying out widely different tasks, it is possible to apply the findings of one trade, with modifications, to other trades. Moreover, by means of a system of charting it has been found possible to classify trades according to the members of the body most used in them. Thus, one trade uses the left hand to a far greater extent than the right, and when the right is used at all it is doing what is called "transporting empty." Only for two short intervals are both arms occupied simultaneously. It is evident that the work of the right hand can be transferred with a slight change in conditions either to the left hand or to the feet. The importance of this knowledge where disabled soldiers are concerned can scarcely be exaggerated.

The results of the application of these methods of motion study and methods like them are, as we have stated, given in the report of the Industrial Fatigue Board on work in an iron foundry. This report gives no indication that the full measure of scientific help available was made use of. Indeed, it is rather suggested that the means employed were quite simple, though clearly founded on the principles we have enunciated. Nevertheless, the results achieved were very remarkable.

The foundry in question is the Derwent Foundry at Derby, and the application of scientific method

is due to the managing director, Mr. Jobson. In May 1915 the foundry began to work for the Ministry of Munitions, and it continued to do so till the end of the war. The Ministry estimated its capacity for moulding and casting hand-grenades and fuse-hole plugs at 3000 articles weekly.

In August 1915 Mr. Jobson began to apply his study of motions, and by August 1918 a capacity of over 20,000 plugs weekly had been reached. Not only so, but Mr. Jobson

found that a firm he visited recently was pressed to turn out 5000 plugs, whereas his own works, *with less plant* employed on the job, yielded an output equivalent to over 20,000 per week.

Again, during the period August 1916–18, the value of the output from his works upon this particular job increased fivefold, although the price paid by the Ministry was meanwhile reduced by 13·3 per cent. These results were obtained by a judicious combination of movement study, training of workers, improvements in appliances, shorter hours of work, and higher wages. The employees were told: "We are out for higher wages, less hours, and more output. Will you help us? Are you willing to have your movements studied so that we can find out the best way, adopt this as standard, and cut out useless and unproductive movements?"

The men consented. The motions were analysed with the aid of a stop-watch merely. Tools and materials employed were arranged appropriately, and such movements as could be performed simul-

taneously were combined. In the case of moulding and casting 90 per cent of the increase in output is put down definitely to improved efficiency on the human side. Over 20 per cent of this is ascribed to training.

Moreover, as soon as training was begun, the working hours were reduced from 54 to 48 per week. Instead of starting at 6.30 A.M. they began at 8 A.M. every morning, working until 5.45 at night, with an hour's interval from 12.30 to 1.30 for lunch, save on Saturday, when work stopped at 12.15. These hours were continued unchanged after the men had been trained. During training each man was paid by day rate, his daily wage being raised to about 25 per cent above the standard rate for the district.

As stated, the new method increased output by more than 300 per cent for jobs which include machine work. For example, a job which before the war gave an average output of 48 per day of 10 hours was standardized under the new system at an output of 147 per day of $8\frac{3}{4}$ hours. This meant an increase in hourly output by nearly 284 per cent, an increase which was regularly surpassed by trained adult workers.

CHAPTER XI

VENTILATION AND OUTPUT

PROBABLY there is no more momentous factor in modern industry than the ventilation of the factory. This may sound an extreme, even an exaggerated statement ; it is neither. The reason why employers have not devoted more attention to the subject is to be found in the fact that they are ignorant of the meaning of ventilation and of the part which it plays in maintaining active, healthy workmen.

The old idea of ventilation was that the object aimed at should be to provide a plentiful supply of fresh air. It was stated that so many cubic feet of air were necessary for each inhabitant of a room. It was confidently asserted that large quantities of oxygen must be available at all times in order that the blood might have a liberal supply of this gas. Oxygen, declared the exponents of these views, is the first essential of all energy, and unless it is present in great quantity the worker will become intoxicated with his own waste-product, carbonic acid gas, and be rendered inefficient.

This attitude was the direct outcome of the great physiological work which had revealed the secret of the circulation of the blood and the mystery of the exchange of gases which goes on in the lungs. The physiologists were able to point to the fact that each time a man draws a breath he takes oxygen into his lungs and each time he expires air from his chest he drives out carbonic acid gas. They naturally assumed that unless the supply of oxygen was kept at a high level this vital process might come to an end.

The result was a tremendous " boom " in what may be described as oxygen ventilation. The very name of this gas acquired a deep significance. It was mentioned with reverence, and everything which seemed to militate against its prevalence was looked upon with grave suspicion. Buildings with low roofs were taboo ; elaborate schemes were invented whereby the air containing carbon dioxide gas might be got rid of and oxygen substituted for it.

Unhappily the results achieved, though they were important, were not sufficiently great to warrant the idea that the whole truth of this matter of ventilation had been revealed. So that a reconsideration of the problem became necessary.

This reconsideration began with a return to the study of the healthy body and its reactions to its environment. It was then seen that in the enthusiasm for oxygen and for what is called " gaseous exchange " a very important aspect of respiration had been left out of account, namely,

the function of the lungs in getting rid of surplus heat.

In the lungs the blood is exposed to air of a lower temperature than itself, and heat passes from the blood to the air and is got rid of. So that the lungs are a valuable means of keeping the bodily temperature even, just as the skin is.

But the matter goes farther than this. The skin itself plays a tremendous part in the cooling process, and it also acts as one of the great sense organs of the body. By means of the skin all tactile stimuli are received and transmitted to the brain, and the general responses of the individual depend therefore upon the " flow of sensations " to this great sensory area.

It was now evident that any circumstances which (1) interfered with the cooling mechanism of lungs and skin ; (2) prevented the continuous stimulation of the skin—and possibly also of the lungs—so necessary to bodily vigour ; and (3)—the old idea—diminished to a dangerous extent the exchange of gases must seriously affect the well-being of the man or woman concerned. Thus the problem of ventilation assumed a new complexity and a new complexion.

The first-fruits of the study of it, which began when these considerations were appreciated, was the recognition of the importance of currents of air. It was pointed out that in most of the rooms in which ventilation seemed to be bad there was abundant oxygen for all needs. It was the stillness of the air rather than its impurity which caused the trouble.

In the absence of current, or movement, the inhabitants of the room ceased to receive any stimuli on their skins and consequently experienced a sense of lassitude, of heaviness, which deprived them of the power to work or to think. The value of a fan was thus perceived at once. The fan helps not because it draws out impure air from a room, but because it creates a current of air. The older fans were fitted in holes in the wall; nowadays fans are fitted anywhere, preferably in such a position that their action sets up a good strong movement of the air.

But there was another factor to be considered in these badly ventilated rooms—the heat of the room. If the room was cool the absence of currents of air was much less vital a matter because the stimulus of the cool air was often of itself enough to maintain the inhabitants in comfort and activity. A hot room, on the other hand, soon became insupportable unless the air in it was moved about. Moreover, the heat of the room prevented cooling of the body from lungs and skin, and so increased the discomfort and lassitude. And if the air in the room was damp as well as hot things became much worse because then evaporation of sweat could not occur and another important method of cooling was put out of gear.

The whole of this vast and complex problem has the most important bearing upon work in factories and shops because unless it is understood and unless action is taken a great deal of energy which might be usefully employed in production will go to waste.

It is therefore gratifying to find that the Medical Research Committee has devoted attention to it and has assisted Dr. Leonard Hill, the well-known physiologist, in his researches into the subject. Dr. Hill has published a special report to the Committee which, though it is of a highly technical nature, contains important information. He points out:

"Of the inflow of sensations which keep us active and alive, and all the organs working in their appointed functions, those from the great cutaneous" (skin) "field are of the highest importance. The salt and sand of wind-driven sea-air and sea-baths act on the skin and brace up the body. The changing play of wind, of light, of cold, and warmth stimulate the activity and health of the mind and body. Monotony of occupation and external conditions for long hours destroy vigour and happiness of, and bring about the atrophy of disease in, man."

He then goes on to point out that for the purpose of controlling the heating and ventilation of rooms the thermometer has acquired an authority it does not deserve. It is not, as we have insisted above, the actual temperature but the cooling power of the air, dependent not only on temperature but on movement, the radiant energy of the sun or other source received by the skin, the drying power, dependent on humidity, movement, and radiant energy which affects the nervous apparatus of the skin on which the maintenance of health and vigour depends.

So important are these facts that Dr. Hill goes the length of declaring that:

"In a factory, slim and fat men doing the same physical labour require very different rates of cooling, and to effect the greatest efficiency of working should be grouped in different shops differently ventilated."

The ideal method of warming and ventilating rooms then would give radiant heat, a warm floor, and agreeable movements of cool air—the conditions of a sunny spring day out of doors. To some extent those conditions can be obtained in factories, and their attainment will assuredly prove valuable to the owner. It will result in clear heads and active muscles among his workpeople, and that sense of freshness which always conduces to good work.

The case of the Rand Mines is cited as being an illustration of defective ventilation—in very difficult circumstances—which is paid for at a high price. "The loss of life, of health, and the economic loss of labour at these mines continue at a very high figure." But the same defects are found much nearer home and are due, in this climate, to ignorance and apathy. If only employers realized that they themselves are paying a high price for their failure to improve matters a change would soon be brought about. Indeed, the trouble is not confined to works and factories. Dr. Hill writes :

In the Chamber of the House of Commons the ventilating current is driven up through the floor in such a way as to cool the members' feet while their heads are exposed to more stagnant air. Cold feet and stuffy heads result—just the wrong conditions for legislators. Certain members are susceptible and complain greatly

of the ventilation, others do not. Noses vary. The thermometer, it is true, shows a uniform temperature of 63° F. : but the Kata-thermometer shows that the members' feet are cooled at a rate which is 40 per cent or more greater than the cooling of their heads. Sitting on a bench in the House of Commons I found my left nostril, narrowed by the deflected septum, become completely obstructed in the course of a very few minutes. During an inquiry conducted by the Ventilation Committee of the House of Commons I was allowed to make experimental alterations in the system of the ventilation in one part of the Chamber. Closing up the floor inlets there, I introduced air at the Gallery level. Under these conditions my feet were warm, my head agreeably cooled by a slight and grateful movement of the air, and my nasal airway unobstructed. Changing to and fro from the part ventilated on the old system to that ventilated by the new, my left nasal airway each time became obstructed by the old, opened by the new.

It seems pretty certain, thus, that not only does inefficient ventilation make workers "heavy" and "stupid"—no matter how great the air space may be ; it also tends to induce the best conditions for the catching of colds and the propagation of infectious diseases.

Meanwhile, the employer who values his own interests will see to it that the system in vogue in his shop or factory is adequate. He will discover for himself whether the air is kept reasonably dry, and whether it is made to circulate in such a way that a braced and vigorous attitude characterizes his workpeople. He will see to it also that the air is neither too hot nor too cold. Having assured

himself on these points he will, if he is wise, call in expert assistance and have any alterations made which may be necessary to secure the ideals aimed at.

The physical effects of such care will be increased working power, a greater freedom from epidemic disease, and a diminution in the number of accidents owing to the quickened wits of the workers. In addition, there will be a moral effect, the reflex of the evident interest taken in the health and well-being of the operatives. This moral effect cannot be over-estimated, especially at the present time.

It was found that a week of breezeless foggy weather in Winnipeg in 1913 produced more bronchitis, pneumonia, and colds than usually occur throughout the whole Manitoba winter. To some extent this may be due to the fact that people huddle closer together in cold, wet weather. It has been shown, for instance, that a zone within one metre of a consumptive patient "is particularly dangerous for guinea-pigs kept within cages and exposed to saliva-spray infection." Yet even here the danger is much increased "when doors and windows are shut in winter." Again, in an Australian troopship three decks were well, the fourth badly ventilated. The incidence of infective pharyngitis and epidemic catarrh was ten times greater among the badly ventilated troops. In the case of Canadian troops camped in tents on Salisbury Plain under extreme conditions of wet and discomfort, excellent health was observed. When these men were transferred into huts catarrhs and sore throats

broke out and spread rapidly and there were even cases of "spotted" fever (cerebro-spinal meningitis).

Infection, while, of course, it plays its part, is thus not the whole story so far as the spread of epidemics is concerned. The weather also plays a part. It is evident that the ventilation of a room or workshop determines to a very great extent the "weather" therein so far as the workers are concerned.

This factory "weather" may be hot and damp and stuffy if the ventilation is bad. In that case the immediate effect—in addition to the dulness and lethargy produced—is a swelling of the mucous membrane of the nose and air passages. This swelling has recently attracted a good deal of attention and has been proved experimentally. The mucous membrane in the hot room or "shop" becomes congested and covered with thick secretion. It remains somewhat swollen even after the man or woman has gone out into the open air.

Such a swollen turgid mucous membrane probably supplies the requisite breeding-ground for the germs of disease. And these germs are very likely indeed to be present in the hot, heavy air of an ill-ventilated apartment, especially if many individuals are at work. Dr. Hill writes :

> In crowded rooms infection takes place from mucous spray, sneezed, coughed, or spluttered out in speaking. The inhaled bacteria will be caught by the swollen mucous membrane covered with thick secretion. In those who live out of doors, not only is the membrane

kept taut, but the flow of arterial blood through it is rapid, for the inhaled air has to be warmed up and moisture rapidly evaporated from the membrane, so as to saturate this air at body temperature. Thus more lymph comes out into the membrane from the blood-vessels, and this contains protective substances. Offensive bacteria are either washed away or destroyed and thus kept out. On the other hand, a membrane covered with thick secretion and congested offers a medium more suitable for the bacteria to settle and grow on, for it is boggy and stagnant, not flooded with fresh lymph. . . .

But not only is there preparation of the ground for infection from without, there is also preparation of it for infection from within. Most of us carry about the germs of pneumonia and sore throat, and are only protected against these diseases by the resistance of our own tissues. The first lines of defence suffice to hold up the enemy. He remains on the ground, but does not enter. When, however, the walls of defence are cast down by the hot, ill-ventilated atmosphere, the scene undergoes a dramatic change. The germs begin to establish themselves, and disease results without any infection from other people.

It has been suggested that the lymph poured out by the nasal mucous membrane, so-called " mucin," is probably the first line of anti-bacterial defence. In most acute influenzal throat affections the mucous membrane is red and dry, and the mucin fluid is absent. It has been shown, too, that the mucin can inactivate certain germs, notably that of poliomyelitis. It is consequently to be expected that if much

mucin is present infection will be less likely, if little is present it will be more likely.

This idea receives striking illustration from the fact that employees who are exposed to certain mild irritants in the course of their work tend to keep free of colds. Dr. Hill quotes the case of the London Electric Railway Company, which reported that in the great influenza epidemic of 1918 only 3 per cent of their employees who worked in rooms ventilated by ozonized air were absent from the disease. Ten per cent were absent from rooms not so ventilated. Ozone is a mild irritant, and excites a flow of nasal mucin. Workers in sulphurous acid factories are said to be remarkably free from colds and influenza, and the same thing applies to workers in explosive factories who breathe nitrogen-peroxide and nitric-acid fumes.

> The evidence collected by Dr. Shufflebotham from poison-gas factories shows that workers in gases which irritate the nasal membrane are relatively very free from influenza, the few infected do not seem to have secondary symptoms. . . . Chemical manufacturers have a low phthisis mortality.

It is not, of course, possible for employers to use irritants to aid ventilation, but it is possible for them to see that the stimulation of cool, dry air is present in their works. This cool, dry air acts on the nasal mucous membrane to stimulate it. A flow of mucin is encouraged and the germs of disease are killed or kept at bay.

Lest there be any further doubt of this, experi-

mental work was carried out to determine the effect of various atmospheres and various occupations on the resisting power of the nose and throat. In the majority of persons increased swelling and redness follow exposure to heat, and the reverse occurs in cold. The nasal airway is thus blocked in hot and opened in cold states. If a fan be used, however, so as to blow air on the face the effect of the hot room is much modified. Moist heat produces greater changes than dry heat.

The New York Commission on ventilation investigated this matter and reached the conclusions which we have just enunciated. They reported that of the persons examined by them representing all kinds of work " about 3 per cent of the students had chronic diseases of the nasal passages, 19 per cent of the outdoor workers, 35 per cent of the furnace-men, and 46 per cent of the laundry-men."

It is thus evident that the employer who fails to consider the ventilation of his factory or shop is not only losing output because of the soporific effect on his workers, he is also running a risk of epidemic disease which will place his hands on the sick list and so unhinge his business. If an epidemic comes he will be the first to suffer and will suffer more severely than his neighbours. Further, he may find epidemics actually beginning on his premises.

We come back, then, to the need of scientific ventilation, not as means of satisfying some inspector whose ideas may or may not be modern, but as a means of increasing output, conserving business, and augmenting profit. The wise employer will not

tolerate makeshifts in this respect; he will insist upon having a really reliable system, a system approved by those competent to judge.

America in this respect is leading the way, and indeed every week some new indication of the importance attached to these problems on the other side of the Atlantic comes to hand. In the *Bulletin of the United States Labour Statistics*, No. 250, it has just been laid down that different trades must face their own special health questions and devise special methods.

> These methods [it is said] include work along the lines of preventive and curative medicine and surgery, the safeguarding of the health of all the employees through the physical examination upon entrance, the relief from the strain of especially monotonous and fatiguing operations through the granting of rest periods or change of occupation.

Many firms in America have already evolved systems of treatment and prevention on their own account. A total of 375 establishments reporting to the Government, employing over a million men and women, have, according to the last issue of *The Medical World*, accounted for 265 hospitals, while 110 offer first-aid equipment, 171 report their own physician, 181 their own nurse, and 131 first-aid attendants. The significance of these figures is enhanced by an appreciation of the need of preventive measures such as ventilation, lighting, and so on. The statistics of treatment given show that 261 establishments employing 770,000 men treated,

on an average, 196,772 per month. In other words, 24 per cent of males and some 27 per cent of females were afforded treatment.

The importance of this is realized when it is remembered that an untreated case of, say, sore throat in a badly-ventilated room may end by placing half the effectives of that room *hors de combat*. Treatment removes the source of infection; ventilation keeps the lines of defence in good condition. The epidemic is "nipped in the bud," or rather is not able to start growing at all.

It is inconceivable that what our friends in America are so eager about should leave us unmoved. Our need of health and vigour is even greater than theirs, for we are working on a sadly reduced population and, moreover, on a population which has been victimized by many diseases. Our margin of safety in a health sense is low. We cannot afford to take any risks. We may use as an illustration of this the condition revealed by a survey of the tinplate industry.

The rolling of tinplates is a very heavy operation, which is conducted in five stages. The whole cycle of the five stages occupies about ninety-six minutes, when 46 bars of 29 lbs. each are rolled. There is never any break in the rolling process of more than a very few minutes' duration right through the working week—*i.e.* from 6 A.M. on Monday till 2 P.M. (or 12 noon) on Saturday. The workmen seldom pause more than four minutes between any of the stages, and there is no delay when the shifts change, as the "doubler" of one shift puts in the furnace

the bars required by the succeeding shift, and the fresh men are all ready and waiting to take their turn.

The conditions of work are thus heavy; they are also trying. The temperature of the air, for example, in the neighbourhood of the workers was found to be as high as 110° F., and it is stated that this figure affords but an inadequate idea of the heat experienced. There are radiations from the red-hot sheets of metal, there is the partly opened furnace, and there is the heavy manual work being carried on. "The men," says the report, "stream with perspiration within a very few minutes of starting work, and they drink many pints of home-brewed ginger-beer, milk, cider, and water during their shift in order to quench their thirst."

It is manifest, therefore, that in this industry there are great opportunities for the scientific ventilator. It was sought to find out just how valuable his services were likely to prove and what bearing they would probably have upon the recorded output of the factory.

The first point, and a very interesting one it is, which was noted was that the millmen's output actually varies with the atmospheric temperature, and is distinctly smaller in summer than in winter. This can be seen from the following table, which is an abridged form of Table VI. of the report:

[TABLE

RELATIVE HOURLY OUTPUT PER MILL AT FACTORY B

Month.	Average no. of boxes of plates during years 1912, 1913, 1914, 1915, 1916, 1917, and 1918.	Mean external temperature.
		Deg. Fahr.
January . .	103	41·7
February . .	104	41·9
March . .	104	43·4
April . . .	101	48·2
May . . .	98	54·9
June . .	99	58·2
July . . .	98	61·6
August . .	96	61·5
September .	98	58·5
October . .	98	51·7
November .	99	46·1
December .	102	42·7

The ventilation of Factory B, to which the above table relates, is described as "about an average standard." Air from outside was driven along an overhead pipe from which branches opened about 7 ft. above floor level. In this way air douches were delivered between each furnace and pair of rolls, and, in addition, there was a pipe coming up from the floor and discharging air close to the waist of the rollerman. Each douche could be turned on and off at will, but a serious defect of the system was that the air current was not powerful enough to extend in any strength to the legs and lower part of the bodies of the men. The head and shoulders were thus liable to get too much cold air, and in consequence the men often turned off the current themselves. In one factory they actually smashed the ventilating apparatus because of its inefficiency.

Another factory where the ventilation was even

better than at B was A. Fans and paddles were employed here. The bottom of the fan was about 7 ft. from the floor, and there was a fan between each furnace. The draught was more marked than that occasioned by the other system. The seasonal variation of output resembled that of Factory B.

A third factory, Factory E, had no artificial ventilation whatever. The millhouses, moreover, were situated in rather a confined space. There was much more seasonal variation in output than at Factories A and B, as is shown by the following table :

Month.	Average number of boxes of plates during years 1913, 1914, 1916.
January . . .	109
February . . .	104
March . . .	104
April	97
May	96
June	100
July	96
August . . .	91
September . .	98
October . . .	102
November . .	102
December . .	107

Thus in January, the mean figures show, the output was no less than 9 per cent above the average for the year (100), while in August it fell to 9 per cent below the average. The seasonal variation was three or four times greater than at Factory A. In Fig. 12 is shown graphically the effect of the seasons on output—output and temperature being displayed

by lines which, it will be observed, run almost together.

In Fig. 13 is shown the seasonal variations at Factories A, B, C, D, and E. We have already discussed A, B, and E. In C the ventilation was moderate. In D there was no ventilation at all. It will be seen from the curves that lack of efficient ventilation occasioned a great falling off of output during the hot months of each year.

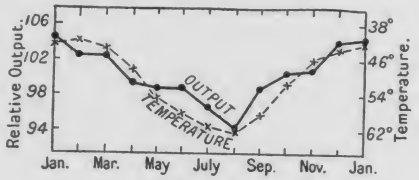


FIG. 12.

The following table still further illustrates the point :

Factory.	Ventilation (artificial).	Mean Dec. & Jan.	Output July & Aug.	Percentage reduction in summer.
A	Good	100·5	97·5	3·0
B	Moderately good . .	102·5	97·0	6·4
C	Moderately (or none) .	105·5	94·4	10·4
D	None (but good natural)	104·5	93·0	11·0
E	None (but poor natural)	108·0	93·5	13·4

The loss in unventilated factories is thus considerable, even when these rather rough figures are considered. It is stated that :

It may be concluded that the output observed even in the coldest months of the year falls considerably short

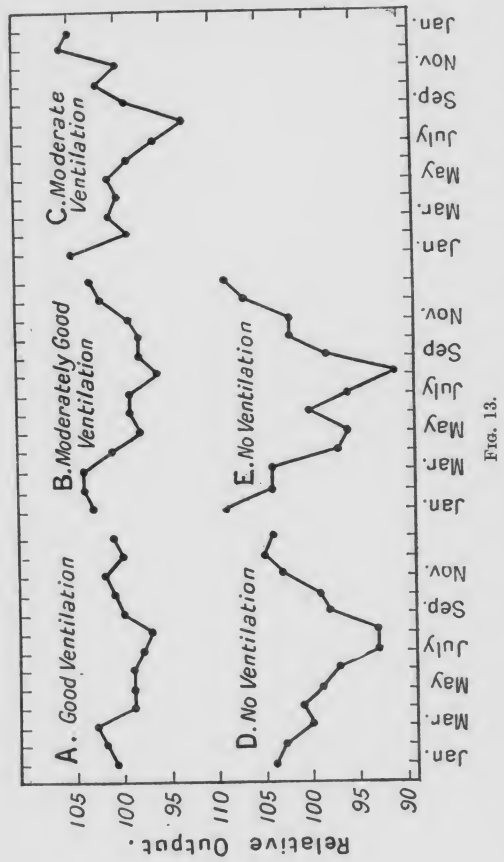


FIG. 13.

of what might be attained with a perfect ventilation system.

Reasons are given for supposing that efficient ventilation installed in an unventilated mill might increase the annual output of that mill by 12 per cent, though this is only an approximation. A really efficient system should combine the " plenum " or air pipe method with the use of fans and paddles. Fresh air should be driven into the building by mechanical means. It should be discharged at a suitable height above the floor level, and then distributed to the men below by means of paddles. Moreover, mechanical arrangements should be installed whereby the speed of revolution of the fans could be changed at will. In Factory A, for example, the fans always revolved at a rapid speed from March till October, when they were stopped for the year.

Again, it is urged that the rate of revolution of the fans ought not to be constant, but rhythmical, or gradually waxing to a maximum speed, waning to a minimum, and then waxing again. Such rhythmic ventilation is more pleasant and efficient than steady ventilation, for the air currents are distributed better. The extra expense of such elaborate ventilation would be more than compensated for by an increased productive power of the men. It is added :

In many American tinplate works cold air is driven up from the floor of the millhouses, but a workman who had experienced this system told me that it was

much less pleasant than the English system, as it produced chronic irritation of the skin of the legs. Again, in some American works the mill floor is cooled by running cold water through pipes inserted in the floor-plates, and this method is said to be very efficient in keeping the millhouse cool.

Secondly, it is suggested that changes should be introduced in the clothing of the workers. It must never be forgotten in dealing with the question of ventilation that the skin plays an enormous part in maintaining working efficiency. It is upon the skin that the currents of cool air play ; it is in the " radiator " formed by the skin that the blood of the worker is cooled and his temperature regulated ; the skin is itself a delicate physiological mechanism so constructed as to be able to transmit stimuli from the outside world to brain and other organs. The importance of allowing a free circulation of air about the skin is thus manifest. Indeed, it is an essential factor in ventilation. At the present moment, before starting work, the men put on a short loose flannel shirt ending at the waist and open at the neck, and they thus help to keep the upper portions of their bodies cool ; but throughout the " shift " they wear the same trousers and pants in which they came to the works, and these garments are generally " thick and woollen." Thus the lower part of the body, the part exposed to the red-hot sheets of steel, is kept very warm, and is unable to benefit from the ventilation currents of air.

It is urged that the men should put on grey flannel trousers without pants : " for their underclothing

must become saturated with perspiration, and though they generally change it when they get home, there is necessarily a delay of some minutes during which they may get chilled and acquire rheumatism." Tinplate workers are especially liable to this disease, the figure given by Collis and Hilditch, who investigated the subject, being "two to five times" more liable to rheumatism, rheumatic fever, and neuralgia than workers such as brass casters, grinders, and cutlers.

Another point the ventilating engineer must bear in mind is the humidity of the air. This, as we have seen, is a matter of vital importance because cooling depends to so great an extent on evaporation. It was found experimentally at Factory B that the output remained constant so long as the average humidity of the air did not exceed 79 per cent saturation. Output fell 3 per cent when the air was 80 per cent or more saturated. At Factory D the effect of humidity was *nil* until the air was 85 per cent or more saturated, when the output was reduced 3 to 4 per cent. At Factory C humidity did not affect output at all.

These small effects of humidity are clearly due to the fact that the industry is carried on at very high temperatures. Such temperatures lower the relative humidity of the air enormously—for instance, air completely saturated with moisture at 60° F. becomes about half saturated when heated up to 80° F., and a third saturated when heated to 90° F. Hence the millmen can never be working in air of more than moderate humidity.

It is an interesting fact that at the same time as these findings were being arrived at another body, a committee of the Institute of Mining Engineers, was in process of reaching some very striking new illustrations of the meaning and value of ventilation. This committee carried out a research into the atmospheric conditions in deep and hot mines. It found that the control of temperatures in deep mines was dependent on adequate ventilation. The Coal Industry Commission recently placed the absolute limit of depth at which mining could safely be carried out at 4000 feet; but one conclusion which has already emerged from the researches which are now proceeding "is that under the ordinary means of ventilation mining can be carried on at 5000 feet, and would, if these methods were extended by artificial means, be practicable at an even greater depth."

CHAPTER XII

TUBERCULOSIS IN INDUSTRY

With the ending of the war has come a renewed determination on the part of all classes of men to rid our civilization of the plagues which continually threaten it. The war against disease has been declared anew, and every citizen is called upon to play his part so that life may be rendered not only safer but more productive and more useful.

Not the least of the great enemies who must be conquered is tuberculosis, the "White Plague," that subtle foe which lies in wait for all, and which by slow stages brings the strongest and the best to ruin and death. In its varied forms it is responsible for one-ninth of the total death-rate of the United Kingdom. It claims a total of over 50,000 victims in England and Wales each year. In our industrial districts, especially where the workers of the land live, it is so rife that, according to Dr. Thomas E. Nuttall, in the administrative county of Lancaster, with a population of about $1\frac{3}{4}$ million, there are over 2000 deaths annually from tuberculosis.

But death is only a small part of the bitter toll of

this scourge. In Great Britain tubercle of the lung, "consumption," holds at least 150,000 persons in a state of disablement during those very years which should be the most industrially productive. Moreover, according to a conservative estimate, there are in perpetuity in this country 500,000 persons who have sustained infection by the disease, although they are not at the moment disabled so that they cannot work. In the year 1918 no fewer than 92,000 fresh cases of the disease were notified, and this represents but a proportion of the total number of cases arising.

We may set this dreadful disaster down in tabular form thus :

Per Annum—England and Wales

Deaths	50,000
New cases	92,000
Cases disabled	150,000
Cases infected but not disabled	500,000
Total	792,000

It is thus manifest, as we have already suggested, that practically every industry in the country must contain tuberculous employees and that consequently the chance of contracting this disease in industrial life where men and women work for long periods in close contact must be very high indeed. If the plague is to be fought it must be fought not only in the home, but also in the factory and the workshop, and employers must see to it that the plans made for the health of their workpeople take this disease into account and set up barriers of the strongest kind against its propagation.

It should be understood in the first place that unless the disease is discovered in its early stages, little or nothing can be done. The victim, long before the true nature of his malady is recognized, may be sowing seeds of death among his fellow-workers. He may be carrying home with him infection which will presently break out among his children. He may even be a source of danger to his employer, should he come into personal contact with him.

For this reason, medical examination of employees at regular intervals is of the first importance. In dusty trades, as we have already pointed out, it is absolutely vital. The inspecting doctor must carefully investigate all symptoms, and must be in a position, if need be or if he has any doubt, to have the patient's expectoration examined for tubercle bacilli. He should also be able to send the patient for X-ray examination.

Even with these precautions, early cases will occasionally be missed, for unhappily tubercle bacilli do not, as a rule, appear in the lungs until the disease is well established.

Repeated examination will, however, minimize the danger of missing an early case, because symptoms that might not arouse suspicion on a single occasion will become important when they are found to have persisted over a period. This, of course, means that the medical officer to the factory will keep accurate records of his examinations of the workpeople and of their symptoms.

It cannot be too clearly understood that consumption is a disease which the powers of the body are well able to cope with so long as these powers are unimpaired. At post-mortem examinations it is exceedingly common to find old, healed tubercular scars, showing that the patient, during his life, threw off the disease and overcame it. A short period of rest, a liberal diet, a visit to the country, are often sufficient means to turn the scale against the disease.

It is often urged that to demand of employers so great a care of their workpeople is unreasonable. We have frequently controverted the idea, for it is a fact that employers who have instituted medical inspection invariably speak in warm terms of the advantages gained by this step. An American writer, Dr. Mock, has recently collected statistics from ten large industries in which very excellent medical staffs are retained, and his conclusions are worth the most careful consideration. He presented the following table in the *Journal of Industrial Hygiene*:

1. Total number of applicants examined in the year . . .	118,900
2. Total number employed having disabilities that did not interfere with selected work . .	41,158 (34·7%)
3. Total number rejected for work because of disabilities . .	11,433 (9·7%)
4. Total number having no disabilities of any moment . . .	66,309 (55·6%)
5. Total number of regular employees	102,400

Dr. Mock declared:

It is fair to assume that these 11,433 applicants who were rejected for work would have soon lost their posi-

tions because of inefficiency, or would have left because of sickness. Certainly by the end of a year practically all of these would have been eliminated from the working force.

The loss must have been great from decreasing efficiency due to disease, from increased accident rate, from loss of time due to sickness, and the resulting sick benefits. One authority has estimated the cost of living and training per individual at $35. If that be accepted the 11,433 rejects would have cost the companies concerned, had they been employed, $400,155. A more recent estimate places the cost of living and training at $45. If the medical work be taken as costing $2·50, we get the following balance-sheet :

	Dollars.
1. Saving to ten concerns from rejection of physically unfit	400,155
2. Cost of entire medical work in these concerns	256,000
3. Profit to the concerns from this one branch of medical work	144,155

In addition, the fact that slightly disabled employees were placed in work suitable to them, and so saved from breakdown, adds about $144,000 to the employers' profit. These figures refer to all diseases. The case of tuberculosis forms an excellent illustration of what they mean. For not only does this disease incapacitate its individual victim, it spreads with great facility and so gains other victims. Thus there is loss of a widespread character, much of which, represented by acquired skill and dexterity, is quite incalculable.

It is, of course, a truism that the tuberculous problem is closely allied to the problem of housing. This, again, touches the problem of transport, for so long as workers are crowded together in areas suitable only for factories, so long will this disease spread among them. Here is to be found the justification for those industrial cities upon which certain of the great employers of labour have expended so much care and energy. Movements are now on foot to encourage smaller employers to combine together and become the landlords of their own workpeople, by acquiring suitable sites and erecting houses of good and sound construction. This work is still in its infancy, but undoubtedly there is a great future before it. An employee who comes from a clean and wholesome house, where his meals can be properly prepared, and where his leisure can be spent advantageously, is manifestly a much better investment than one whose home is situated in a slum, whose food is ill-cooked and worse served, and whose leisure belongs for the most part to the local public-house. No attempt, so far as we know, has been made to prepare a balance-sheet of profit and loss based on a comparison between the two types of home environment. But experience would suggest that, original outlay notwithstanding, the landlord employer of the type referred to makes a handsome profit on his foresight and public spirit.

Another potent enemy of tuberculosis is regular exercise. This subject has received a great deal of attention lately, since, indeed, it was found that weedy and "unlikely" young men from our in-

dustrial areas became strong and well-developed under military training. The result of this knowledge has been a demand for physical education on a national basis. As usual, the more enlightened employers have seized upon the possibilities offered and instituted courses of instruction in their works. It is too early as yet to assess the results in terms of, *e.g.*, a falling consumption rate. But evidence is not wanting that such a declension is, in point of fact, a consequence of the movement. Physical education does not, of course, destroy the tubercle bacillus, but it raises the resistance of the man to infection. It makes the "soil," if that term may be used, unproductive. The germ cannot flourish there and tends to die out should it gain a lodgment.

Among the friends of the tubercle bacillus, if we pass over dirty, ill-constructed homes, are lack of sunlight, alcohol, and venereal disease. The first deserves close and careful attention. Very many factories and workshops are ill-lit, dingy, and damp. The windows are so placed that direct sunlight never penetrates to the interior. As a result, the remarkable germ-killing power of sunlight is entirely lost and the spread of every kind of disease facilitated. This is a matter which can be set right in most cases with great ease, or at least with but little real difficulty. A recent experiment, where the lighting of a workroom was altered so that the sun was able to shine into it, resulted in an immediate fall in the number of cases of coughs and colds and a general improvement in health. The workers, who had tended to be pale or sallow in complexion, were

found to keep a better colour and to be more cheerful. Their work improved in quality; moreover, their resistance to disease, and this applies especially to lung disease, increased. Coughs and colds, anæmia, dyspepsia, and so on are common precursors of tuberculosis.

Alcohol, when abused, is a potent reducer of resistance. By means of it the "tone" of the whole body is lowered, the individual cells become flabby and inactive, and the seeds of disease grow without difficulty. The public-house of the wrong type and the slum are old associates. The cheerless home serves as the incentive. The result is loss to employer and employed, and a richer harvest for all the deadliest diseases.

CHAPTER XIII

PROBLEM OF VENEREAL DISEASE

THERE is another affliction which, though less spoken of than tuberculosis, is not less deadly in its work nor less costly in its effects—syphilis.

The subject has been dealt with by many authorities, but so far its industrial aspect has been largely overlooked. Yet there can be no doubt, as is stated by Dr. Oliver in the *Journal of Industrial Hygiene*, that it " causes a sufficient decrease in the efficiency of the working world to rank it as one of the most important economic problems in industry."

Little or no attention was devoted to this disease by the British committee on the health of munition workers. The times, it is true, were serious and the need of haste was great. Yet venereal disease was increasing very rapidly all over the country, and steps might have been taken to consider its relation to industry. Unhappily, as Dr. Oliver points out, syphilis has until recently been largely taboo as a subject of discussion, both here and in the United States, so that we have even yet only a slender knowledge of the prevalence and extent of the

disease. A false sense of modesty prevents due publicity being given to its depredations.

The city of New York has during the past few years made venereal diseases notifiable. In the fourteen weeks from July 4 to October 3, 1914, 25,633 cases of all infectious diseases were returned. Of this list syphilis was head with 6432 cases, or 28 per cent of the whole. Tuberculosis came second—5525 cases, or 21 per cent ; diphtheria third, measles fourth, and scarlet fever fifth. It is obvious that a case of diphtheria or of scarlet fever is much more likely to be reported than a case of syphilis—for in connexion with this latter disease secrecy is so very often the policy pursued. Consequently, it is probable that Dr. Oliver is not making an over-estimation when he thinks that only about 50 per cent of the total infections by syphilis were ever brought to light. It is certainly the case that a disease which is so extensive must form a serious cause of industrial inefficiency.

The American Army has furnished some other statistics which are worth quoting. Thus, during the fifty-three weeks ending September 27, 1918, there were reported 178,204 cases of venereal disease. About 16 per cent, or 27,000, were cases of syphilis, the remainder being gonorrhœa. During 1917, 750,000 days were lost to the Army through venereal disease. In 1918 things were very much worse, the loss reaching what is described as the " alarming total of 2,067,000 days."

The most momentous fact in connexion with these latter figures is that no fewer than 85 per cent

of the cases had become infected with syphilis before they entered the Service. This gives point to Colonel Vedder's statement that " 20 per cent of the young adult population " (of America) " from which the Army is recruited in peace time are luetic " (syphilitic), " and 5 per cent of our young men in college are infected. Since syphilitic infection is so common and so productive of disability, and has so far evaded sanitary control, it is believed that syphilis is a greater menace to the public health than any other single infectious disease, not even excepting tuberculosis." Osler puts syphilis third or fourth among the killing diseases, and estimates the actual deaths annually at 60,000, " which makes it rank first among infections." Leredde estimates that it kills 25,000 persons each year.

Not only so, but syphilis kills or disables the worker at the very time when his earning capacity should be at its best and when his skill should be of most value to his employer. This is one of the diseases which seem to play with their victims through youth and strike them down in early or late middle age. What doctor has not seen the man of 40 to 50 whose heart or blood-vessels are breaking down as the result of uncured syphilis. Most cases of aneurism owe their origin to this disease, and it is now practically certain, thanks to the researches of Sir Frederick Mott, that general paralysis of the insane is due to the same cause. Locomotor ataxy, aortic disease, cases of apoplexy, cases of insanity of various kinds, can often be traced to this scourge. Thus the infection, contracted it may be in early youth, strikes down the valuable worker at the very moment when he is reaping his harvest, robbing him of the fruit of his labour, and his master of services which are often only too difficult to replace.

But the evil goes further even than this, for syphilis seems to bring a tendency to other diseases. Thus, according to Dr. Oliver, some careful investigations have shown that between 20 and 30 per cent of tubercular patients also suffer from this disease. " Syphilis has been shown to be an important predisposing factor in tuberculosis." Again, Sir William Arbuthnot Lane, the eminent surgeon, has recently declared that syphilis ranks high, in his regard, among factors inducing to cancer. Another surgeon recently called attention to the frequency with which syphilis of the tongue was followed by cancer of that organ. From a study of figures obtained in an American general hospital it appears that between 20 and 30 per cent of the patients were infected with syphilis.

Here, then, is a disease which most commonly begins in early life, which lies latent—we do not yet know how great a tax it is on the strength of the individual during this period—for years, and which may predispose to consumption and cancer. In most cases, if uncured, it breaks out in middle life or earlier, producing some deadly affliction from which the victim gradually dies. It is dreadfully contagious, and destroys not only its immediate victims but their progeny. Industry has certainly no worse foe. The so-called " tertiary " syphilitic

works great havoc. "They are the potential causes of accidents to themselves and to others. When injured their disability is always prolonged. They are generally chronic absentees, inefficient employees, and a source of trouble at all times"—that is to say, those of them who are able to work at all after the late form of the disease has shown itself. The following case is cited from Dr. Oliver:

B. R., aged forty-four, a foreman in one of the busiest departments, became so inefficient in his work as to attract the attention of his manager and his fellow-employees as well. From a bright, active, energetic foreman he had suddenly changed to an absent-minded and careless workman. Important orders were forgotten, and worry over his condition was evidently making things worse.

Knowing that something was wrong his manager sent him to the doctor's office for a complete examination. Several months previously, while on his vacation, standing on his front porch one evening, without any warning, he fell over, became unconscious, and remained so for a short time. When he recovered consciousness he knew nothing of what had happened. After a few days' rest in bed he recovered and returned to work. The incident bothered him a little, but not to the extent it was destined to when he had several similar attacks. His family physician pronounced it "nervous exhaustion," but he did not improve under treatment. . . .

He was told of his condition—by the works doctor—and then admitted having had an initial lesion twenty years previously, for which he had taken little or no treatment. Anti-syphilitic treatment was begun at once, and has been continued ever since. His health is

very much improved, he has had no more attacks, and his work has returned to better than its previous standard.

We have given this case in full because it illustrates exactly the miserable condition to which syphilis in its late stages is able to reduce its victims and shows the heavy economic loss occasioned by the disease. It should suffice to prove to every employer of industry that the campaign against venereal disease concerns him closely and that all the help he is likely to be able to afford that campaign will be money invested rather than money given away.

The main platform in the campaign is necessarily education. If young men and women understood not only the moral aspect of the case, but also the dreadful danger they are running, there can be no doubt that the incidence of the disease would diminish. This is a great opportunity for the employer of industry, because he has it in his power, if he likes, to distribute knowledge among his workpeople either as printed leaflets prepared by a medical authority or by means of lectures given by a doctor. In the same way the promotion of healthy games among the workpeople will tend to minimize the danger. These methods are said to have been very helpful in the Army.

The second means of prevention is what is known as prophylaxis after exposure. A controversy is raging at present on this subject, but all are agreed that the sooner a man cleanses himself after exposure to infection the less likely is he to contract

the disease. Various preparations for " immediate self-disinfection " have been recommended. Dr. Oliver writes :

> It is our duty to teach men that once they are exposed, prophylaxis does protect in the great majority of cases if taken immediately after or within six hours of exposure—the quicker the better. . . .
>
> In the (American) Army of 23,702 men taking prophylaxis over a period of twenty-two weeks only 1 per cent developed a venereal disease, although many did not apply for many hours after exposure.

The employer might well consult with his doctor and obtain the consent of the local authority to placing means of prophylaxis at the disposal of his workpeople. It is but fair to add, however, that in doing this he would encounter opposition from those who regard such a step as morally indefensible.

Medical examination of entrants should, of course, be carried out, and if syphilis is discovered it should be treated. If it occurs in the works it should also be treated at once. Dr. Blaisdell, of Boston, selected 60 cases that came to him, and found that between the time of their infection and the time of their first appearance for treatment these cases had " exposed 134 other individuals " directly, and had endangered 422 through family life and 651 by occupational association—in all 1227 people. Thorough treatment at the earliest moment and segregation are thus necessary. The Medical Research Committee has recently issued a report showing that when very early treatment—by

Salvarsan—is given the disease does not tend to recur.

This disease alone illustrates the vital importance of the doctor in industry. In fact, it makes it abundantly certain that the time has arrived when the doctor must take his place as the indispensable helper of both employer and employed.

CHAPTER XIV

EYE-STRAIN IN INDUSTRY

It was found during the war that the number of eye injuries increased very much. This was more especially true in relation to such injuries as "strain," and was ascribed to the fact that the work in munition factories often demanded a high degree of visual acuity. Moreover, the lighting was often very defective.

These eye-strains made up a heavy total of disability, and so affected to an important degree the bulk of output. Nor was this immediate loss their worst feature. Some of the injuries inflicted are still operative and are still costing industry a heavy toll. It is for this reason that attention is now being directed to the question of lighting in factories, and also to the necessity for examination of the eyes before certain kinds of work are undertaken. We have referred to this movement in a general way when considering the relation of eye defects to street accidents, and also the question of eye disease in miners.

The evidence of increased loss during the war

came from every area. The out-patient book at the Ophthalmic Department of the Glasgow Royal Infirmary showed that the number of those suffering from "fires" and other trivial eye troubles who applied for relief during August 1916 was "more than double the number who had come suffering from similar injuries during the corresponding month in previous years." A report from Coventry put the time lost from eye injuries at 2000 days' work in this town alone.

Industrial work may cause impairment of eyesight in several ways. The eyes may be injured by exposure to intense heat or to poisons, they may be struck by flying particles, they may be "strained" as a result of uncorrected errors of refraction or as the consequence of bad lighting.

As regards accidents, it may be said generally that these represent some 5 per cent of all industrial accidents. Most of them are trivial, yet even the trivial ones cost the employer time and money, for as a rule they represent from a half to a whole day lost. Moreover, to the initial damage must be added the danger of infection and a subsequent suppurative process. On this head a surgeon has written :

> If the injury be neglected, or if it be treated by any one who is unskilful or careless, sepsis will almost certainly occur ; and all experience teaches that infection of the wound is a far greater danger than the actual physical damage to the ocular structures. The occurrence of sepsis at once transforms a very trivial injury to the cornea into a suppurative keratitis which may

run a prolonged course, lead to more or less impairment of sight, and in serious cases even destroy the eye.

This danger is real and serves as another argument in favour of good first-aid work in every factory and workshop.

Eye-strain is more insidious than accidental injury; it is also much more crippling. It may be accentuated by age, fatigue, or unsatisfactory health of the worker, by near distance work, insufficient or excessive illumination, abnormal position, or long hours. During the war evidence was collected on this subject, and embodied in a special report. According to this eye-strain and headache followed :

(*a*) Inadequate light, both artificial and natural.
(*b*) Artificial lights, adequate in amount but so placed as to throw a glare upon the eyes of the workers.
(*c*) Employment of workers (whose eyesight should be aided by suitable glasses) to carry out fine work without first testing their eyesight.

The condition, again, may be but one manifestation of a general fatigue. It is thus more likely to occur when long hours are worked, when night shifts are necessary, or when workers are ill-cared for, under-nourished, anæmic, or of poor general physique.

An inquiry made into the eyesight of 156 workers in a factory producing munitions of war showed that most of the eye defects were found in the fuse department, where fine processes were in operation, involving close attention. In the work of making

shells only about 19 per cent of eye defects were noted, but in the fuse department the proportion reached 64 per cent. The report of this inquiry states :

> In the fuse department 8 per cent of the workers were obliged to obtain glasses since starting factory work, 19 per cent complained of eye-strain, of whom 12 per cent found sight difficult in the night-shift, and 2 per cent found the eye-strain increasing in severity. Besides these, 10 per cent appeared to have latent eye-strain, as shown by severe headache, blepharitis, etc., and probably required to have their eyes tested. Conjunctivitis was present in 11 per cent. Many workers complained of the artificial light falling directly on their eyes, and others said that the reflection of the brass work of the fuses was dazzling. The artificial lighting in the factory was by electric lights placed over the benches. . . . On the other hand . . . several girls had been warned at school by the school medical officer that their sight was defective, and had neglected to obtain glasses. Five workers had obtained glasses but did not wear them.

Eye-strain, then, is a powerful enemy of efficiency and of output, especially in those industries in which fine work has to be carried out. Consequently, its prevention is a matter of the greatest practical importance. The employer who consults his best interest will neglect no precaution to this end.

There are certain general measures which have a bearing on preventing eye-strain. These may be grouped together as measures designed to improve the physical health of the workers—we have dealt

fully with them in previous chapters. But, in addition, a number of special measures must be taken. Of these one of the most important is certainly the examination of eyesight by competent observers. In the first instance, the medical officer attached to the works or even the nurse or welfare supervisor may be able to apply some simple tests. In all cases in which abnormality is discovered the patient must be referred to an ophthalmic surgeon or eye hospital for regular examination and, if necessary, glasses. When workers are to be examined for glasses the nature of the work they propose to carry out must be specified, since special and different glasses may be required for distant vision and for near work.

Under certain conditions the eyes should be protected by goggles. This is necessary when particles are likely to be driven against the worker. In acetylene welding the glass should be tinted or specially prepared to obscure the chemically active rays at or beyond the violet end of the spectrum—the so-called "ultra-violet rays," which possess a power of damaging living tissue. Dark blue glass has usually been employed, but there are objections to this. Dark "neutral smoked glass" is better. One authority recommends "a very deep rose tint."

We have already dealt with the treatment of accidents to the eye by "first-aid" means. The question of lighting, therefore, remains as the last, and most important, measure of help in this group of industrial affections.

The Factory and Workshop Act does not, curiously enough, contain any provision in regard to the

lighting of factories. The question has, however, been dealt with in a report of the Departmental Committee on Lighting in Factories and Workshops published in 1915. The essentials of good lighting are thus summarized:

1. Adequacy.
2. A reasonable degree of constancy and uniformity of illumination over the necessary area of work.
3. The placing or shading of lamps so that the light from them does not fall directly on the eyes of an operative when engaged on his work or when looking horizontally across the workroom.
4. The placing of light so as to avoid the casting of extraneous shadows on the work.

The principal effects of good lighting were summarized by an expert witness, and his conclusions deserve the most careful attention. The quality of work, he declared, and of output suffer if the illumination is inadequate, particularly in the case of the delicate operations often called for. Adequate illumination on the other hand assists the supervision of workers, with the result that carelessness and errors on the part of newly-trained employees is more readily detected, and instances in which a worker requires a rest are noticed more speedily.

Inadequate illumination by adding to the difficulties of skilled labour increases the nervous strain on the operators and reacts on their physical condition, the risk of accident is increased and machines become more liable—through insufficient care—to break down. Further, it is generally recognized that

operators work more cheerfully in well-lighted rooms. Bad lighting depresses their spirits and lowers their output.

Natural lighting is always to be preferred to artificial on grounds of health as well as on grounds of economy. Roof lighting is superior to side lighting, especially if it can be arranged that the light enters the shop from the north. In a good system of roof lighting the light is " uniform."

Again, much can be done to make the light effective by painting the walls of the room in light colours and keeping the ceilings clean. This, too, affords an effective background for dark objects.

Moreover, the natural light can be aided in several ways :

By deflecting vertical light into the room by means of reflectors or prismatic glass or by whitening the surface of an external wall or building which obstructs the light.

The position of permanent working points should be so arranged that adequate light will be available for each. Efforts, too, should be made to see that the supply of light is not cut off by dirty windows or other removable cause. All windows must be so constructed that they can be cleaned easily.

In the use of artificial light, glare must be avoided so far as possible. The light must be as steady as possible and shadows must not be cast upon the work. Gas has its advantages, but it should not be forgotten that each cubic foot of gas pollutes the atmosphere to the same degree as one adult person.

The best form of gas illuminant is, of course, the incandescent-mantle burner, properly ventilated. Both gas and oil give off heat, water vapour, and carbon dioxide gas, and these, in bulk, may exercise a deleterious effect on output. In this respect electricity is easily the most hygienic of illuminants : no oxygen is used up, no carbon dioxide gas and no moisture are produced.

Another form of eye trouble in industry is Miners' Blindness. The subject was almost unexplored until a very brilliant investigator, Dr. Lister Llewellyn, the first Tyndall Mining Research student of the Royal Society, essayed its elucidation. Before he began to work it had of course been well known that workers in deep mines tended to develop a condition of the eyes known as nystagmus and characterized by a curious lateral or side to side twitching. This condition as well as being exceedingly unsightly led in many cases to blindness, and was therefore regarded with great anxiety by the men employed in those mines.

Dr. Llewellyn returned to his subject at a meeting of the North Staffordshire Institute of Mining Engineers. Miners' nystagmus, he declared, was an occupational disease of the nervous system found only among workers in coalmines. The first symptom was failure of sight, especially at night time or when the sufferer was called upon to perform the more skilled portions of his work. The man then complained that the lamps dazzled his eyes, and, sooner or later, that the lamps and all surrounding objects danced before him.

In addition to these symptoms there is headache, varying from slight pain between the temples to attacks of extreme severity, giddiness on exertion or stooping, inability to see at night time, and dread of light. In fact, the man is reduced to a deplorable state of weakness in many instances.

The economic aspect of the disease is not less depressing. Dr. Llewellyn estimated that if a man were off work for a year the loss to the country would be at least £359, made up of £65 compensation and £294 loss of coal output (235 tons at 25s. a ton, pithead price). He calculated that since 1913 there had been at least 6000 men disabled each year from nystagmus. If it were assumed that each case "played" six months in the year the total direct cost to the country would be 3000 times £359, or over a million pounds a year. This meant a loss of nearly three-quarters of a million tons of coal a year, and a cost of one penny per ton on coal.

We may figure this bill of loss as follows:

Loss in man-power, 6000 per year.
Loss in money, at least £1,000,000 per year.
Loss in coal, 750,000 tons per year.
Loss in cost of coal, 1d. per ton added.

In addition, we must take account of the accidents, both small and great, which occur as the result of this dazzling and blindness. Dr. Llewellyn said:

There is always the possibility that a catastrophe may result from the failure of a fireman or collier suffering from the disease to detect the presence of gas. I have examined 41 nystagmus cases for the detection of the firedamp "cap" on the safety lamp. Only 4 detected it correctly and 16 failed to see the "cap."

One might suppose that a disease at once so ruinous to health and so costly would have been attacked by every weapon available. The average reader will therefore be surprised to learn that miners' nystagmus is not only a preventable disease, but is actually a disease the prevention of which has been worked out and understood.

It was found, for example, that in certain mines which are lighted by daylight nystagmus did not tend to occur. In other mines in which the illumination was very good the incidence of the disease was low, whereas in deep and badly-illuminated mines the number of cases tended to be highest. The natural inference, in the first instance, was that lighting had something to do with onset.

Further work only tended to confirm this early impression. The miner in the badly-lit mine had his sight continually intrigued by a point of light, and so a movement or pull of the ocular muscles took place which was the first-fruit of the mischief.

It may be said then that deficiency of illumination is the dominating factor in the causation of this disease. In the opinion of the investigator who first drew attention to the matter, Dr. Llewellyn, it is "so important that all other factors become insignificant." Thus the problem of prevention is nothing more nor less than the problem of lighting. Certain factors, however, must be taken into consideration:

1. Nystagmus is a disease of gradual onset, and the

average number of years of underground life before failure of sight has been found to be twenty-five.

2. The illumination in open-light pits is five times that in safety-light pits.

3. Cases of nystagmus, although uncommon, do occur in naked-light pits.

It is thus evident that at any given time in our ill-lit pits a certain number of cases of this disease will always be maturing. This factor should be borne in mind. If it is overlooked, an owner who does his duty and installs a proper lighting system may suffer keen disappointment when cases of nystagmus continue to occur. He will be apt to jump to the conclusion that after all lighting was not the real cause of the disease, and that his effort has been wasted. The moment it is realized that these " new cases " are, in fact, old cases, the result of the old bad system and not the new good one, the owner will discount them.

The full benefit of any measures taken will, therefore, not be effective for some years. They will show their good effects more tardily, of course, and to a less degree, if they are inadequate. Thus it has been laid down that " the illumination in safety-light pits must be increased at least five-fold." Even then nystagmus will not be completely eradicated, for the sensitiveness of eyes varies within considerable limits.

It is a lamentable fact that very little seems to have been done in this country to attack this great evil. The miners themselves are fully alive to their danger. At their conference at Keswick, in July

of 1919, they demanded a special inquiry, and instructed their executive committee to make an investigation on its own behalf. It was declared that the disease was acting with " increasing frequency," and that an addition to the illuminating power of the miner's lamp was urgent. The electric light was satisfactory in that respect, but its present design made it useless for the detection of dangerous gases.

This difficulty has, we believe, been overcome to some extent, though it remains a difficulty. The Americans have certainly adopted a form of electric lamp which is so constructed that the miner carries a small battery to illuminate it on his person. This course is said to afford excellent results and to be free from danger. The home miners have, however, expressed some anxiety and it is a fact that the light is not much used.

The value of the American light found a strong advocate in the columns of *The Times* in March 1920 when Dr. J. S. Haldane, the eminent physiologist and authority, wrote that :

> From recent personal experience in American coal-mines I can speak strongly of the comfort and efficiency of the type of lamp which your correspondent refers to, and which has been thoroughly investigated by the scientific staff of the American Bureau of Mines. This lamp not only leaves a miner's hands free at all times, but enables him to get the source of light close up to what he is working at. The resulting great advantage depends upon the fact that the illumination varies inversely as the square of the distance of the lamp.

Dr. Haldane went on to urge the importance of further research on this subject, declaring that in this and many other matters connected with mining the inadequacy of our provisions for research and the red tape of existing official regulations were delaying the trial of what appeared to be better methods. His views were echoed to a great extent by Dr. Llewellyn. He urged in the strongest terms that research work to discover a better illuminant for safety-light mines was essential. He suggested that the Mining Association of Great Britain and the Miners' Federation should each subscribe £50,000 to a research fund. He added:

> Coal is wanted everywhere, and when you improve the illumination of the coalmine you will not only diminish the incidence of nystagmus and lessen the frequency of accident, but you will also increase the coal output. Nystagmus not only causes total disablement, but is also responsible for lessened production in men who have not yet failed.

The mining industry certainly cannot afford to allow this blot to remain on its reputation. It should be encouraged to turn to research by the excellent results which have been achieved by the scientific method in another of its own departments.

The matter, however, in the case of miners' nystagmus must be carried to a higher plane than mere profit. It is no less than a national crime that these men are being maimed at present. Were the disease not an old and well-established condition to which, unhappily, people, and especially the

miners themselves, have become accustomed, the present state of affairs would give rise to a strong public outcry. Familiarity has bred indifference, and complacency is ready to talk of "risks incidental to the calling." This is the wrong spirit; it is a spirit unworthy of the great tradition of British industry.

CHAPTER XV

THE DUST PERIL

SOME time ago the *Monthly Report* of the British Steel Smelters, Mill, Iron, Tinplate, and Kindred Trades' Association published a short series of articles on industrial diseases as affecting the workers in this industry. The subject of pulmonary tuberculosis was dealt with, and it was stated that one of the causes, so far as industrial life is concerned, was the inhalation of dust at the works.

The disease known as pneumoconiosis [it was stated] is known to kill large numbers of Staffordshire potters, Cornish and Transvaal miners, and Sheffield grinders. Dust from any cause, especially that produced in the manufacture of manure from basic slag, causes bronchitis, asthma, chronic cough, and emphysema and pneumonia, and no doubt predisposes the body to attacks of the tubercle bacillus. As these dust diseases develop insidiously, the workmen engaged in such occupations should have their chests examined periodically and any signs of commencing disease should be regarded as a disqualification for that particular kind of employment.

This, be it observed, was written in a journal

belonging to the workers. It reveals the fact that they are fully alive to the dangers and necessities of their calling.

The United States Department of Labour, impressed by the need of action, has formed a Committee on Mortality from Tuberculosis in Dusty Trades, and this body has just issued a preliminary report which is of great importance, as outlining the work to be undertaken. The State of Vermont, and its granite- and stone-cutting industry, form the basis of the statistics so far obtained. It was found that the mortality from tuberculosis was extremely high in the granite-cutting districts, equalling 121·8 per 100,000 of population, as against 81·4 for the State as a whole. This is regarded as sufficiently important to justify a prolonged investigation. In our own country, which has led the way in this work, the same kind of investigation was carried out by Dr. J. S. Haldane on behalf of the Institution of Mining Engineers.

These findings are of deep interest alike to the employer and to the medical man. Dr. Haldane stated quite unequivocally that a sharp distinction must be drawn between coal and other kinds of dust. He found no evidence in the mortality returns, for either old or young miners, that dust inhalation had hitherto caused appreciable danger to life in British coalmining. On the other hand, the introduction of stone dusting as a practical and effective means of preventing coal dust explosions had altered the situation, for it had been found that stone dust exercises a very baneful effect.

Dr. Haldane and other workers were able to show that, whereas stone dust alone seemed able to produce severe lung disease, stone dust *plus* coal dust did not produce this effect. Animal experiments of various kinds were carried out, and it was found that the cells lining the air vesicles of the lungs seemed to be stimulated by coal dust to unusual vigour. Thus stimulated, they carried the dust away and eliminated it. If, on the other hand, stone dust only was present, this was not got rid of, the cells apparently not being stimulated. The addition, however, to the stone dust of coal dust resulted in the same effects as when coal dust alone was used — both dusts were removed from the lungs.

It is evident that these results are of the utmost practical importance to the mining industry, for, as has been emphasized on several occasions, the respirators in use do not as a rule afford the men adequate protection. Just recently, however, experiments with new respirators have been carried out by the Bureau of Inspection of the New York State Industrial Commission. It was determined that with the use of one half ounce of clean absorbent cotton, pinned or otherwise fastened to a piece of cheese-cloth five inches wide or of coarsely-woven muslin of sufficient length to tie about the head, or of a length, if preferred, to cover thoroughly nose and mouth, all dust would be filtered out for a period of four hours or more. The absorbent cotton of the respirator should be covered with a small piece of muslin or cheese-cloth to prevent the small

particles of fibre touching the lips or tongue of the operator wearing it.

Such an apparatus, it is claimed, will filter out the dust in the air being breathed. It is cheap, light, and does not obstruct vision, while it can be changed daily at small cost. The respirators do not break or rust and cause no excessive perspiration.

Meanwhile from another quarter comes a series of important observations on the enormous losses suffered owing to dust and on the effects produced on the patient when dust is inhaled. In the *Journal of Industrial Hygiene* it is stated that miners' consumption—and especially stone miners—ranks on a par with lead-poisoning as the most dangerous industrial disease. The Medico-Actuarial Investigation found a mortality of 226 per cent of the expected, according to the mortality table, among miners other than coal miners. Studies of individual life insurance companies have shown mortalities of over 300 per cent of the expected, and with the death-rate from pneumonia and tuberculosis running seven to ten times the average.

These high rates, as we have pointed out, are not in coal mines, but in stone or metalliferous mines. They are confirmed on every hand. Thus a big mining centre, where the operations were all in silicious rock, showed the following death-rate per 1000 from tuberculosis alone :

1906	5·04
1907	5·55
1908	6·49
1909	7·01

In copper miners in Montana the death-rate from respiratory diseases was 9 per 1000 miners, and Dr. Haldane found the death-rate among metalliferous miners in Cornwall to be (1900–1902) :

Age . .	20-25	25-35	35-45	45-55	55-65
Death-rate .	2·7	17·3	33·2	32·2	42·6

We can thus estimate for a death-rate of from 7 to 10 per 1000 employed from lung diseases in districts where hard rock mining is carried on.

Dr. Landis, of the University of Pennsylvania, has recently written in the same journal regarding the types and characters of the dusts which are dangerous. For example, he declares that the more jagged and angular the particles are the greater is their power for mischief, a fact which no doubt weighs in favour of granite and quartz as disease-producing rocks. Again, it has been declared that, in general, dusts appear to be more injurious as their chemical composition differs from that of the human body or from the elements of which the body is normally composed. Thus lime dust, a normal constituent of the body, though it is angular in form is but feebly irritating to the lung. Native plaster-of-Paris is also relatively harmless. Cement dust, in spite of enormous quantities inhaled, was found to be without peril.

Other things being equal, it has been found that the finer the dust the more dangerous it is. It is only the very minute particles which gain entry to

the lungs. Thus one observer declares that the majority of visible silicious particles, as detected by polarized light, in sections of a diseased lung, vary from 2 to 12 microns in maximum diameter ; larger particles were not found in the lung tissue, but only in the cavities of the air tubes. Another investigator found, after most careful work, that 1 micron was the usual size (that is, a diameter less than one-eighth of that of a red blood corpuscle). These particles, indeed, accounted for 70 per cent of the whole ; only a negligible number of particles were seen whose longest measurement exceeded 8·5 microns, and the very largest observed was 10·5 microns. The prevailing outline of these particles was narrow and elongated, with one or both extremities pointed.

Not only size, but also concentration of the particles is important. For example, if a worker is exposed to the dangerous type of small dust in a closely confined space, the effects are more severe and disease changes are more quickly produced than if exposure occurs in a well-ventilated room or in the open.

The very severe effects produced in the gold miners of South Africa and the zinc miners in south-western Missouri are largely due to the fact that the rock dust accumulates in underground passages and chambers. In the Rand, holes are bored into the rock which, if not moistened, emit a constant stream of fine dust which thoroughly impregnates the atmosphere ; and, after blasting, sufficient time is not allowed to permit of the dust settling.

The finest dust is produced by blasting; over 99·5 per cent of the particles are below 12 microns in diameter, and the average diameter is under 2·5 microns. The dust, too, is produced in enormous quantities, though only over a short space of time. The dust contents of the air, indeed, after blasting may, it has been calculated, contain per cubic metre as many as 86,000,000,000 particles of a dangerous size.

Finally, the length of exposure to the danger is a matter of great moment. In most cases four or five years elapse before a worker begins to show signs of trouble, even where the dust is of the most dangerous type, and the conditions are very bad. In the case of less dangerous dusts, ten or fifteen years may elapse before the mischief declares itself.

Dr. Landis thinks that it is not so much the injury caused to the lung that makes workers in these inorganic dusts susceptible to tuberculosis, but rather the fact that tubercle bacilli are easily carried into the lung in the dust. If an infected worker is careless in spitting on the floor, the sputum becomes dry, and mixes with the dust, thus making it easier for the bacilli to reach the lung. The dark, humid atmosphere of the mines, too, may aid in prolonging the life of the bacilli. It was observed that the tubercle bacillus would survive in the acid mine water for at least two months. This worker is inclined incidentally to think that tuberculosis, as distinct from injury of the lung, is too often ascribed to stone dust, and may in a good many instances arise from other causes in these workers.

The prevention of this industrial disease is by no means on a satisfactory basis at present, and a great deal of work remains to be done. Meanwhile, however, certain clear indications have emerged:

1. All workers should be examined on entering the mines which are known to be dangerous. If tubercle is found, or even suspected, the worker should be refused forthwith. He is a danger to himself and his fellows.
2. All workers should be examined periodically and removed from work at once if any signs are detected.
3. Disinfection should be carried out as far as possible in all mines and workplaces.
4. Ventilation systems should be carefully supervised and rendered as efficient as possible.
5. "Wet drills" should be substituted for dry ones.
6. Respirators should be worn, especially those designed on the American plan, and made as has been detailed above.
7. Perhaps stone dust should be mixed with coal or shale dust, as suggested in the report by Dr. Haldane. This is admittedly a difficult business and would have to be "carefully thought out to ensure that enough of it" (*i.e.* the coal dust) "were breathed."

These precautions, if taken in the silicious trades, would unquestionably lessen this very real and deadly peril. Later work may, it is to be hoped, suggest other methods.

CHAPTER XVI

SAFETY FIRST

THE safety of the workman is becoming more and more a question of political importance. During a recent strike a point was made by the men's leaders regarding the large number of platelayers and shunters who meet with accidents in the course of their employment. The same charge has been brought by employees in other trades, and in not a few instances the Government has already moved in the matter.

In the report of the Chief Inspector of Factories for the year 1918 great importance is attached to this matter. It was expected that during the war the number of industrial accidents would increase considerably as a result of the increased amount of machinery in use, the adoption of new types of machines, and the increased number of persons, especially women, employed. This expectation happily was not realized.

It was found that " by continually directing the worker's attention, by signs or short notices, to points of danger . . . and also by securing his

interest and co-operation with the management in the prevention of accidents, remarkable results have been achieved." Accidents were by no means always due to machinery. The three main causes were inexperience, want of thought, and carelessness. Towards the close of the year a meeting of representatives of employers and workers in industry generally was convened by the Lord Mayor of London with a view to inaugurating an industrial safety-first movement on a wide scale. Representatives of Government Departments attended and an association was formed called the British Industrial Safety First Association. The object of this association was to make the objects and methods of the movement as widely known as possible and to advise and assist generally.

The need for such an organization is evident when it is realized that during the year notices were received of 1579 fatal cases, of 53,491 accidents due to machinery, and of 108,663 non-machinery cases. This vast economic loss and waste and the toll of suffering it represents are preventible. Every effort ought to be made by every employer of labour to prevent it.

The Factory Department has already begun to deal with the problem. Accidents are divided by this department into two main classes or groups : (1) Machinery accidents and those preventible by safeguards ; and (2) non-machinery accidents and accidents not due to want of fencing. Of the former it may be said that the strict regulations now in force regarding the fencing of the machines has

served to reduce them considerably. A further code of regulations has recently been issued and its effect is shown by the following reports from divisional inspectors :

Northern Division.—" Perhaps the most noticeable progress towards accident prevention has been in shipyards. Here there have been great advances during the last few years in lighting, in the provision of safer stages outside and inside the ship, in methods of supporting stages by substituting steel uprights and thwarts for wooden ones, and in supervision. In supervision certain firms are going considerably beyond the regulations, and men have actually been appointed, one for each large boat, to supervise the lighting alone."

One firm supplied heavy steel gangways to replace wooden ones, the latter having proved dangerous when a " rush " of workmen took place. Another made great efforts to secure adequate lighting of manholes and entrances to holds down which workers are apt to fall. A suggestion that these should be painted round with an edge of white is made in the report, and seems worthy of consideration. One large firm on the Clyde has already adopted it, and put it into practice. That these precautions are by no means too great was illustrated by the state of affairs prevailing in shipyards which had to be kept dark on account of air raids.

In other trades meetings of employers and employed took place in order that an understanding might be reached regarding which parts of each machine were to be considered dangerous. In some

cases (*e.g.* as regards the fencing to be provided for draw-bands and pulleys, and scrolls of self-acting mules in the cotton trade) the actual form of the guard was standardized. It is claimed that a great work would be accomplished if trade by trade the fencing of machinery could be standardized. The hands of the inspectors would be strengthened enormously thereby, and the opposition which they now too frequently meet with would largely be removed.

The absence of guards on machinery is, however, a small matter when compared with the personal factor. It has been the experience of inspectors that at most some 35 per cent of accidents have been due to insufficient fencing. The remainder owe their origin to the human element, most of all perhaps to " want of appreciation of the danger."

It is manifest that inspectors can do but little to cure this state of matters. A remedy has, however, been found in what are known as " Safety Committees." In one work in which such a committee was started the toll of accident was reduced during the year by more than 50 per cent. The following year a further drop of 12 per cent was achieved.

When a safety committee is being formed the employer should begin by making it clear to his people that he really does mean business and that he is determined to reduce accidents to the lowest possible figure. The committee must, of course, represent all the interests concerned, and the enthusiasm of the workers must be enlisted from the outset. The officials of the trade unions should be

consulted, and every effort made to disarm the suspicion the workman is apt to feel of schemes which originate with his master.

The representatives of the management will be nominated by the employer; those of the employer should be elected by the men themselves on the basis of one or more members from each department. The committee should have the power to co-opt other persons for special purposes. Members should hold office only for a limited period and should retire in rotation. The committee should meet at regular intervals, not less frequently than once a fortnight, and members representing the workpeople should while engaged on the business of the committee be regarded by the employers as being engaged in carrying out the duties of their employment.

These rules may seem obvious; but it cannot be too strongly urged that, inasmuch as the majority of accidents owe their origin to mental factors, the means of prevention must be reinforced by general acceptance, that is to say, by a friendly and if possible enthusiastic attitude of mind on the part of the workers. This can only be secured if the most complete fairness is shown and if full opportunity for discussion is afforded. The men must see their own interests clearly and must act from an impulse to improve their own condition.

The chief function of the committee will be to inquire into accidents of all sorts and kinds. It will be the duty of the employer to furnish the fullest particulars of each accident as soon as practicable after its occurrence. The committee must

also have authority to visit the site of the accident, to make a full inspection, to hear witnesses, and to offer recommendations. It should publish an account of each accident investigated by it, of the causes which led to the accident, and of its own findings. The publicity so obtained has proved to be of great educational value. In one case, as the result of the public spirit which had been cultivated by this means, a safety committee was able to suspend from employment workers who had neglected to take recognized precautions, and a repetition of the offence involved instant dismissal.

Another duty of the committee is to undertake regular inspection of the works in the company of the departmental manager or foreman. It is suggested that:

> They should forward to the employers recommendations as to the proper and effective guarding and cleaning of machinery, the repair and maintenance of all fencing, plant, passage-ways, and works, as to the provision of safety appliances, the regulation of dangerous processes, lighting and ventilation, first-aid and ambulance arrangements, and any other matters having for their object the prevention of accidents and the securing of safer working conditions

Notices calling attention to danger should be striking and simple. A fault of many of those shown hitherto has been that they failed to attract attention. Moreover, they were not changed often enough. Good notices should strike the eye and also the imagination. In one case a clever device was used by which the notice of danger appeared

only when the guard of some machinery was removed, thus calling attention to the absence of the guard and the consequent danger. The following are examples of posters which have been found useful. They are taken from a report of an address by Lord Leverhulme to the students of Sheffield University, entitled " Standardizing Welfare."

THINK
SAFETY
AND
PRACTISE IT.

READ THE SAFETY NOTICES.

WOUNDS.

SEPTIC Wounds, however slight, require careful treatment. Have them dressed daily in the Surgery.

READ THE SAFETY NOTICES.

ACT WISELY.

REPORT unsafe places to your foreman or manager.

READ THE SAFETY NOTICES.

Finally, the safety committee must set up a suggestion box in which any workman may place an idea for improving the means of accident prevention. This plan has already worked well in practice. It helps to encourage enthusiasm among the men, and so makes for that public spirit without which all efforts will prove vain.

We have insisted upon the value of these committees because they promise an immense saving of man power and of pain and suffering. But rightly handled they promise much more than this. They are bound, within a short period, to become health guardians in a much wider sense. They will make it their business to insist upon reforms which promise greater well-being to the worker, and by that very act they will secure greater output to the employer.

We have so far dealt only with the general aspects of accident prevention. There is, however, an important individual aspect which has recently been considered with great care.

Some people are more liable to accidents than others. These persons constitute a danger to all who may be working with them. It is thus of first-rate importance to understand what are the causes which underlie their weakness and how these causes may be dealt with. For so long as a group of employees contains danger-attracting individuals so long will general schemes of safety tend to break down.

The subject was considered in all its aspects a short time ago on behalf of the Ministry of Muni-

tions by Dr. Vernon. He collected accident data at four factories for periods of nine to twenty-five months. In that time some 50,000 accidents happened. They were classified separately under the headings of cuts, foreign bodies in the eye, burns, sprains, and injuries. It was found that eye accidents afforded the most reliable index of incidence, as they were commonly treated within a few minutes of their occurrence. Cuts were fairly reliable; strains and sprains quite unreliable, as treatment was only sought at long intervals after occurrence in many instances.

It was found that the personal factors influencing accidents depended upon several well-defined circumstances, among which speed of production was prominent. For example, the output in a certain factory rose steadily during the morning spell of work and was 11 per cent greater in the fourth hour of full work than in the first hour. It remained high during the first hour of the afternoon spell, but fell off during the rest of the afternoon. The incidence of accidents showed a qualitative resemblance to these output variations but not a quantitative one, for accidents increased ten to thirty times more rapidly than output during the morning spell.

It was concluded that this increased speed of output was the factor largely responsible for the day-shift variations of accident in men, and this in spite of the fact that fatigue necessarily played a part. For it was found that during the night-shift a different state of affairs prevailed. In this, accidents were at the maximum at the beginning of the

shift and fell gradually the whole night through till they reached a figure which was but half the size of the figure of the beginning of the night.

It was found that this remarkable state of matters as regards the night-shift workers was due to the fact that they started work in a state of some excitement and in a careless attitude of mind. They "calmed down" as the night progressed. Further, in factories where output did not vary much there was little variation in the incidence of accidents. Yet here also the night-shift figures dwindled down throughout the whole course of the night.

We have thus two effects—both personal in some respect. The tendency to make mistakes when a pressure of work is on and the tendency to make mistakes when coming to the factory from other interests of the day—what may, perhaps, be called carelessness.

This, however, was but one aspect of the matter. Fatigue also undoubtedly played a part in accident production. For example, at a fuse factory, where women operatives were working a 12-hour day, or 75 hours a week, the accidents were two-and-a-half times more numerous than in the subsequent 10-hour day period. The men's accidents, as the result of this change, were not affected. The women's accidents showed a five-fold increase during the course of the morning spell, as compared with a three-fold increase during the subsequent 10-hour day period; but, again, the men's accidents did not change as between these two periods. The women's accidents

were 45 per cent times more frequent in the afternoon spell than in the morning spell, while the men's accidents were only 7 per cent times more numerous. Also the women were treated for faintness nine times more frequently than the men, and were given sal-volatile twenty-three times more frequently, whereas, in the subsequent 10-hour day period, they were treated for faintness and given sal-volatile only three times more frequently than the men. When the hours of work at one of the shell factories were equalized for the men and the women, whereby the women were made to work nine and three-quarter hours more than they had done previously and the men nine and a quarter hours less, the ratio of women's accidents to men's accidents (corrected for the alteration of hours) increased 19 per cent for the day-shift and 61 per cent for the night-shift.

Three great factors of a purely personal kind thus emerge—the employee's reaction to speed, his reaction to outside influences, and his condition of fatigue. As we have seen, reaction to outside influences greatly affected the number of accidents at the beginning of the night as compared with the number of accidents at the end of it. Not only so, but it was found that night-shifts were much less generally liable to accidents than day ones—the difference was about 16 per cent.

Finally, there were other factors, which, in a different sense, may be said to be personal. Alcohol, for example, certainly increased the tendency to accident. Lighting exercised a profound influence the extent of which necessarily depended to some

extent on the eyesight of the worker. Thus accidents due to foreign bodies in the eye were 7 to 27 per cent more numerous in the night-shift than in the day-shift, though all the other accidents were considerably less numerous. The excess of eye accidents was most marked in the worst lit factories. During day-shift work the eye accidents to men were most frequent in the winter months and most infrequent in the summer ones, though this was not observed in the case of women.

The temperature of the work, too, affected the number of accidents. These were found to be at a minimum at 65° F. to 69° F., and they increased rapidly at higher temperatures (*e.g.* by 30 per cent at temperatures above 75°) and increased slowly at lower temperatures. It was also found that accidents tended to increase as the weather grew colder and to diminish as it grew warmer. In one factory the women's accidents were nearly two-and-a-half times more numerous when the temperature was at or below freezing point than when it was above 47°, while the men's accidents were twice as numerous. Incidentally it may be noted that the women suffered twice as frequently as the men from sprains, and were especially liable to wrist sprains. The women at the shell factories also suffered three times more burns than the men, chiefly from the hot metal turnings: Talking in the shops was found to increase the number of accidents.

If we look at this valuable information from one point of view, we shall see the necessity of better factory conditions, warning notices, and so on. But

if, while recognizing the great importance of such reforms, we alter our standpoint and look at the personal side we shall perceive a new necessity, for it will become clear that in any given work there will always be a few employees—

(1) Whose nervous system is so constituted that it cannot stand pressure of work.

(2) Whose physical health leads exceptionally rapidly to a state of fatigue, and is incapable without disturbance of tolerating changes of temperature, excitement, and so on.

(3) Whose careless methods defeat all efforts to control them.

These are the accident-makers who may be expected to produce trouble wherever they go. The danger attending them is no imaginary one, as a remarkable report just presented to the Medical Research Committee and the Department of Scientific and Industrial Research clearly proves. The report is the work of Dr. Major Greenwood, of the Lister Institute, and Miss Hilda Woods, of the Ministry of Munitions.

These workers set before themselves three possible accident hypotheses. First, that industrial accidents are a pure matter of chance, accidents, that is to say, in the strictest sense of the term as if "one draws the ace of spades from the well-shuffled pack." Secondly, that there is another element present—"that an accident having happened to any individual that individual's chance of sustaining a second accident became different from what it was before."

This train of events is common enough in life. A man may, for example, suffer from a disease and so establish a new relationship to that disease—*i.e.* his chance of getting it again may be much diminished or it may be greatly increased.

Thirdly, it might be supposed that all workers did not start equal, but that some were more liable to suffer casualties than others. For example, if we suppose that the employees of a firm were divided into careful and careless persons, then the chances of accidents among the careless would be greater than among the careful.

It was perceived that if the first idea was correct, all that was needed for accident prevention was administrative reform; if the second was correct, rest-periods and general attention to hygiene might overcome the nervous tendency of the victim of an accident to precipitate another accident. If, however, the third idea was found to be the true one, it would follow that "both initial selection of recruits and also a rapid elimination of those sustaining multiple accidents should have a great effect in reducing the casualty rate of the factory."

In point of fact, the research did point to the correctness of the third view, though the number of cases investigated seems too small to admit of absolutely positive findings. It will thus be seen that there is at least a strong presumption that the prevention of accidents cannot be achieved in full measure unless steps are taken to deal with the personal factor. In most cases an accident is a small matter of a cut or a bruise. But there are certain

types of work in which an accident assumes dreadful proportions and in which the mistake of one man may involve hundreds of fellow-workers in death and disaster.

In such works and factories it is of vital moment that the accident-maker should be found and eliminated. There is now enough evidence to justify this step, for the presumption is strong that if he is allowed to remain at work he will be the source of more and more trouble. One day he may, by his constitutional defect or his carelessness, become the cause of a great disaster.

CHAPTER XVII

FIRST AID

In the first place, it should be pointed out that an Order on this subject has been issued by the Home Office under section 7 (2) of the Police, Factories, etc. (Miscellaneous Provisions), Act, 1916. The two fundamental principles of these Orders, as outlined by Dr. Bridge, H.M. Medical Inspector of Factories, are :

(1) To treat all wounds, however trivial, so that the workman may quickly return to his work in comfort and safety.

(2) To prevent, as far as possible, serious accidents from becoming more severe.

The chief risk in respect of the slight accident is blood poisoning, which, setting in at the site of a trivial wound, may spread to a fatal issue. Treatment must, therefore, be immediate, simple of application, and efficacious. The dressing applied should, in fact, reduce all risk of the possibility of the entry of germs to the wound. For it must be remembered that blood poisoning comes from with-

out; the poison is produced by germs which enter the wound and breed there.

Simplicity is important, because the larger the number of persons who can be taught how to apply a dressing the more chance there will be of getting a wound treated rapidly, and speed is of the essence of the contract. The French Government, for example, found that by moving hospitals nearer to the front the percentage of cases of blood poisoning was greatly reduced—treatment began at an earlier moment.

Again, the dressing must be of such a type that it can be applied without the part which is to touch the wound being handled. A first-aid box constructed to carry this type of dressing can now be obtained. In one factory a reduction of approximately 50 per cent in the number of septic or poisoned cases has followed the use of this box.

The box should contain a number of the sterilized dressings, done up in sealed packets. Boxes should be placed in the works, in positions within easy reach of all the persons employed. It is important to see that the dressings are of several types and sizes, for a dressing cut and designed for a wound of the body or face cannot be used in a satisfactory manner to protect a cut finger. The Orders referred to above require dressings for the finger, hand, or foot, and large dressings for other parts of the body.

There has been a good deal of trouble in connexion with this question of the size of dressings in the first-aid boxes, and a conference of the principal manufacturers of surgical dressings was held on the

subject in which the whole field was carefully reviewed. The question of standardization was discussed. As a result more suitable shapes have been provided, but it is urged that those who find difficulty should make their complaints known at once, so that further improvements may be initiated.

The use of rolls of unsterilized lint and gauze in the first-aid boxes is not to be encouraged. These rolls get handled and moved about, and quickly gather dirt. Finally, they are applied to a wound, and the contained dirt is then transferred to the exposed parts, with, it may be, evil consequences.

The installation of the first-aid boxes will be of little avail if instruction in their use is not given to the employees. The best thing is to organize a series of first-aid lectures. Application should be made to the St. John Ambulance Association and the services of a doctor obtained. Classes can then be formed and instruction given.

A course of instruction in first aid on somewhat new lines arranged by and under the supervision of Dr. T. W. Woodhead, of the Technical College, Huddersfield, has been begun in that town. The course is divided into two parts, elementary and advanced; the former is limited to instruction in the use and application of the first-aid dressing and such treatment as can be carried out in the workroom or the first-aid box. The advanced course deals with first aid generally, and as the syllabus is approved by the St. John Ambulance Association those taking the full course are qualified to enter for the examinations of the Association. Attention is

paid in Huddersfield to gassing accidents in connexion with the manufacture of dyes. Each industry has its own special problems and these would be dealt with in the course of lectures.

The next line of defence is the ambulance room. "It is not generally realized," writes Dr. Bridge, "that wounds that require treatment other than the application of a sterilized dressing are not of a nature that can be successfully dealt with in the workroom." Even in these cases, however, the immediate application of a sterilized dressing from the first-aid box lessens the risk of infection, which may well take place during the transit of the patient to the ambulance room—one need only mention the case of a compound fracture in which the broken end of the bone is a veritable sponge for dirt and germs. But beyond the application of the dressing no attempt should be made to treat wounds in the workrooms. Indeed this kind of zeal must be discouraged, for the washing of wounds is in itself a minor surgical operation. If this is carried out with dirty hands by unskilled persons great harm may result.

The ambulance room is required by order in factories employing 500 or more persons, and all factories should be provided with it. If this cannot be done, however, equipment such as tourniquets to arrest bleeding, and splints may be included in the first-aid boxes. In one factory a well-equipped first-aid "dressing station," the size of a telephone cabinet, with a stretcher, chair, and other additional equipment, has been provided.

The ambulance room is of great importance and should be chosen with care. It should be in such a position that it can be reached easily from all parts of the factory; and it should be possible to carry stretchers into it with the minimum of inconvenience and danger. This is a matter of real concern, for in cases of serious accident much moving and manœuvring of the stretcher is greatly to be deprecated and may prove disastrous. The best plan is to have the room built according to a recognized plan; if this cannot be done an existing room must be adapted. See that the lighting is good, the door wide, and the floor space sufficient.

In one instance, a large engineering works where this accommodation has been provided, each ambulance room is lighted on one side with ordinary casement windows and on the other side with large plate-glass windows over the doors. These windows practically constitute the wall and afford excellent illumination. The floors are of terazzo over cement, and the walls and ceiling parian cement covered with washable enamel. All corners are rounded as in an operating theatre, and the woodwork is white enamelled. In this way the whole apartment can be washed down daily and the chances of infection taking place reduced to a minimum. The precaution may seem superfluous, but the fact remains that in the presence of this good equipment cases of blood poisoning become few and far between. Each ambulance room is fully equipped with a sterilizer for instruments heated by electricity, a cabinet for instruments with the usual glass shelves,

etc., a dressing wagon, a screen, a table, a chair, and a couch. There is also a lavatory basin of good design and a "surgeon's sink." The supply pipes to these fittings are enclosed and the woodwork is white enamelled.

This may be said to represent the ideal. On the other hand, many ambulance rooms have been converted. In some of these defects can be seen; for example, bad lighting, poor ventilation, wooden floors, and wooden panelling of the walls. The trouble about these latter is the difficulty of keeping them clean.

It is important that for quiet and cleanliness the ambulance room should be separated from the workrooms as far as possible. It should also be separated from the sanitary arrangements if possible. It should be heated in winter, preferably by means of water pipes, these being enamelled white like the rest of the fixtures.

It is naturally of great importance to see that the person in charge of this room is competent in every way. He or she should have had considerable experience in the treatment of wounds. A trained nurse answers the purpose well, but care must be taken to ensure that the "nurse" employed really does answer to that description. She should have been trained in a general hospital of standing, and possess a certificate to that effect. Persons holding first-aid certificates are not suitable, except as juniors to a fully-trained nurse. The nurse need not confine her attention to the ambulance room; she should exercise a general supervision of the first-

aid boxes, and also exert her influence in other directions making for health and hygiene.

In the case of small firms a nurse of the right kind may be rather too expensive a luxury. In Sheffield several small firms, whose works are adjacent, have joined together to employ a highly-trained nurse who visits the ambulance rooms at appointed hours, re-dresses old cases, and sees all cases referred to her by the first-aid attendants. Finally, a medical man should be on call for severe cases, and the addition of a telephone to the ambulance room would be valuable so that no time might be lost in summoning the doctor.

The organization of *personnel* would thus be—at the centre the trained nurse, able to communicate from her ambulance room with a doctor, and having, perhaps, a first-aid assistant; at the periphery a series of first-aid boxes, each in charge of an individual who has had a course of training in first aid. In addition, squads of workers, also trained in first aid, should be organized throughout the factory. Each squad would work in connexion with a first-aid box, and the captain of the squad might be the box attendant. The squad would possess a stretcher and undergo "drill" in the use of it from time to time on the lines of the St. John Ambulance regulations.

It has been suggested that in works in which a "Safety First" committee has been constituted, a sub-committee to deal with first aid should be formed. This sub-committee, on which master and men would be represented, would have oversight of the

whole first-aid organization in consultation with the medical man whose services had been retained. Reports of all accidents should be submitted to this sub-committee.

There is a final point of great importance. The ambulance room should be supplied with a few simple restoratives—brandy, sal-volatile, and other substances. In addition, the doctor might be invited to suggest a list of necessary antiseptics and drugs which the nurse could be trusted to use.

CHAPTER XVIII

NOISE IN INDUSTRY

Few employers of labour appear to realize that there is no greater enemy of efficiency in industry than mere noise. The noise of machinery is accepted as being almost a commonplace. The din and bustle of a warehouse is regarded as part of the daily round. That this clatter, this din, are eating away profits is not recognized, for the reason that the effect of mere noise upon the human machine has not been taken into consideration.

So far the subject has been studied only in the most casual manner. Thus statistics of output in a properly silenced factory are not available because, so far as is known, no such factory exists. When the subject is mooted the reply is that, after all, noise is only heard by the newcomer. The man who works among machinery every day ceases to hear it ; its clamour becomes a part of his " mental environment," so that were the clamour absent he would be aware of a sense of loss.

This view is, no doubt, in accord with experience. It misses, however, the point in dispute, which is

whether or not efficiency can be increased by eliminating unnecessary noise. It is here that further research work is so urgently required, for at the present moment waste, and especially waste of human material, is not only extravagant, it is indefensible.

In the meantime we may turn for light to some recent scientific work on the nervous system in relation to the wear and tear of everyday life. The investigations of a great number of workers, including such well-known names as Langley of Cambridge, Cannon, and Crile, have directed attention to the enormous importance of the nervous system in the bodily economy. This system used to be regarded as a kind of telephone-exchange mechanism; we must now rather accept it as the administrative organization of the body. To it belongs the function of dressing our bodies to meet the contingencies of life and of marshalling their resources while the struggle is going on. The "steadiness" of the trained worker is thus something more than a mere expression of facility; it is a demonstration of perfect equipoise between the various parts of the nervous system, and so of harmony in the organic relationships of the body. Every stimulus meets with an adequate response. The call to each effort, to each fraction of a composite movement, is met at once and completely, but without waste. The process, in fact, appears to be entirely automatic and entirely free from effort.

This view of it, however, is really fallacious and accounts for some of the gravest mistakes which

organized industry commits, and goes on committing. There is really, indeed, nothing automatic about the so-called automatic process. Just as a train running round a curve at high speed takes toll of wheels and rails, so man in his most deft actions takes toll of those mechanisms which keep him "on the rails" of efficiency. The speed of the process, when it has been well learned, by no means mitigates this strain; it merely disguises it.

Some recent work on aeroplane pilots has proved instructive in this respect. A man goes off his "flying form," as it is called, in all sorts of odd ways and as a result of a large number of different circumstances. The addition of other stimuli to those which he is accustomed to encounter may precipitate a crash. So may mental worry; so may intemperance. It would seem that the nervous system is attuned to meet certain conditions, and that the presence of others upsets this balance. But, more important, it would seem that each additional stimulus, however constant, makes an additional demand on the resources of the nervous system, for if the pilot is "off colour" he can stand only so much stress and strain, no matter to what high degrees of both he has been accustomed.

To come to a more homely illustration; the piano practice to which one has perforce become accustomed can be tolerated in ordinary circumstances. But a slight illness arises, and then the sound of the difficult and inharmonious playing grows intolerable and is not to be endured. Endurance has been lowered; there is less of it avail-

able for use. Thus it would seem that endurance, tolerance, call it what you will, is a form of expenditure of energy, and no mere passive quality that may be expressed without loss or effort.

The train keeps the line in virtue of the flanges on its wheels, and the bedding of the rails in " chairs " and " sleepers." But this is not the whole of the problem by any means. In taking the curve energy is eaten up on the resistance encountered between wheel and rail. In the same way your automatic worker, who is apparently entirely oblivious to his environment, is really using up energy in order to produce his state of oblivion. He has achieved the difficult feat of concentration. His attention has been divorced from his surroundings and their calls upon it. So long as he is well he will be able to defy any distraction. But if he falls sick his first complaint will be that he " cannot concentrate " and that every trifling noise disturbs him. We surround our sick with silence for their healing.

Noise, then, is no negative and negligible factor in life ; it is positive and active, and it can be ignored or discounted only by the expenditure of effort. This truth may be more clearly understood if the mechanism of response by the body to stimuli from the outside world is understood. Each of the special organs of sense, the eyes, the ears, the nose, the tongue, and the skin, is connected with the brain by nerves. These nerves in turn act upon certain groups of vital nerve cells, or " centres," which control the breathing, the action of the heart, the flow of blood through the abdominal organs and

muscles. Thus, in response to a call for action a man's breathing becomes altered in quality, his heart beats more strongly and more quickly, his blood is pumped from his belly to his brain and muscles. He becomes alert and ready for work or for battle, and this at the expense of a rapid consumption of his bodily resources.

If, however, experience teaches him that the stimulus, be it light or sound or smell, demands no action on his part, his response to it will gradually diminish. He will, apparently, ignore the call and go on as if nothing had happened. He accomplishes this by means of what is called " inhibition," or repression ; *i.e.* he represses the natural tendency to make a full response.

In other words, his nervous system refuses to pass the order to mobilize ; " blocks " it, so to speak, and so protects his bodily mechanism against needless shocks and alarms. But this " blocking " function of the nervous system is itself an expenditure of effort according to the scientific observations which we have quoted. If it is prolonged fatigue results, as is seen in the case of the person who can no longer concentrate his attention and so becomes unpleasantly aware of the circumstances of his surroundings. Consequently the rule emerges that the fewer the number of stimuli reaching a worker and unconnected with his work the more easy will it be for him to do that work efficiently and over a prolonged period.

The view that the worker " becomes unconscious of noise " is thus placed in an unfavourable light,

even if we admit, as we must do, that controlled experiments on the subject are few and far between. In learning how "not to hear" the noise energy is expended, and still more energy is expended from day to day in continuing not to hear it. The nervous system is bearing a burden which decreases the amount of its total value as an organizer of work; the margin of safety is, by this amount, narrowed. What might have been given to positive output has been expended in a negative manner. In the last issue the employer himself must pay the cost of this dissipation. He is in exactly the same position, indeed, as the master who allows his workroom to remain unventilated and in consequence obtains less for his expenditure than he would obtain were a proper system of air currents installed.

But, as we said above, the matter of noise cannot yet be set out in tabular form as a profit and loss account. Too long hours, bad lighting, bad feeding, bad ventilation have all been reduced, as we have shown in previous chapters, to simple matters of pounds, shillings, and pence. The noisy factory has not come within the scope of such a research. It represents one of the thousands of problems which every enlightened employer will soon be considering, and upon which he will demand positive information in the name of business efficiency.

The test should not prove difficult of achievement and in our view is well worth making. Two shops or rooms engaged in producing the same article or "part" might be set aside as the basis of experiment.

The output of each of these should be carefully recorded during a certain period, allowances being made, so far as possible, for inequalities, *e.g.* skill of employees, lighting, ventilation, and so on. One of the rooms should then be "silenced" so far as possible, *i.e.* the noise of machinery or of working processes eliminated by every possible means. The other shop would be left in its former state of noisiness. Output should then again be recorded over a stated period and the results compared. It would then be a simple matter to estimate whether or not increased output in the silenced room paid for the cost of transformation. In addition, the views of the workpeople would prove of great value, for it is abundantly true that every step which makes life more tolerable and more comfortable for the employee redounds to the ultimate advantage of the master.

The present state of industry in regard to noise is undoubtedly very bad. Most factories and very many workrooms are excessively noisy, and induce headache and great weariness in those who visit them only at intervals. It is perhaps largely the fault of the machines, which were evidently designed in most instances without the smallest regard to the noise they were likely to make in working. In every direction, however, improvements are now being made, and it is a fact, gleaned by personal observation and inquiry, that those who operate a quieter type of machine would never willingly consent to return to a more noisy type.

This, therefore, is one of the grounds on which the

medical man and the scientific engineer meet for the mutual benefit of labour and capital. If the doctor formulates a demand for a silenced industry and supports it by facts and figures—and this we do not doubt he can easily do—the engineer will have a clear mandate. Experience has shown that he will not fail to evolve new types of machines which will rid the industrial world of one of the many useless burdens it is at present bearing. As in the case of the abatement of smoke nuisance, we shall all be the richer for the change, and many of us in addition will be spared the severe ordeal of nervous breakdown, which, in times of bodily weakness, is so apt to occur when our environment habitually overtaxes our powers of restraint.

Professor Waller has recently made an effort to record and measure the effects of shocks, of noise, and so on, when these, apparently, give rise to no outward effect, no muscular movement. His first point was to show that such electrical disturbance can occur quite independently of muscular movement of any sort. For this purpose an apparatus was built up which recorded simultaneously the electrical phenomena and the movements of groups of muscles. The patient lay in an armchair reading an unexciting book and often became sleepy in this situation. A stimulus calculated to arouse emotion was now made. The recorder of muscular movement was of sufficient delicacy to show the pulse and to respond to the slightest unconscious movement.

It was found that there was a most remarkable electrical response even to mere ideas, when no

muscular movement might take place at all. Moreover, the most effective ideas were those accompanied by disagreeable or painful emotions. The threat of a burn often proved more effective, for example, than the burn itself. Lighting a match might give a larger effect than the application of the match to the hand. The fear of a bad smell that had just been experienced proved in certain instances to be particularly effective in arousing an electrical dis-

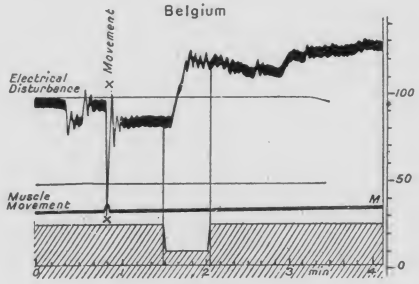


FIG. 14.

turbance. So also the expected prick of a needle produced more effect than an unexpected prick.

This is well shown in the accompanying figure, which is after Professor Waller. In this figure tracings are shown of electrical disturbances and of muscular movement. The patient was a Belgian who was an eye-witness of episodes in the German occupation of her country. It will be seen that the muscular movements are faithfully recorded, for at the point marked × the little finger was raised, and

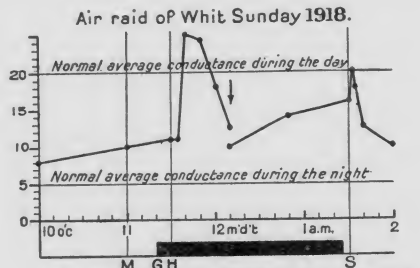
this is duly recorded by a twitch of the apparatus, and so a loop on the line, and a sudden disturbance of the electrical record. When, however, the word "Belgium" was spoken there was no muscular movement, but there was a sharp rise in the electrical record, or what is called an "emotive effect."

Professor Waller takes the view that emotion acts along those nerves which have to do with the nourishment and sustenance of the body, and which are called, in consequence, the "trophic nerves." The ordinary visible signs of emotion, muscular movements, flushing, increase of heart action, sweating, and so on, are in fact phenomena which normally occur side by side with the electrical disturbances he is dealing with. It is possible, to some extent at any rate, to prevent these grosser manifestations —to inhibit them, in scientific language, so that no effect is apparent. On the other hand, the emotive effects which are manifested electrically are not under voluntary control, and so cannot be inhibited. It thus follows that :

> The more perfectly an examinee can control the visible signs of his emotion, the more violently is the galvanometer deflected . . . by reason of his suppressed emotion.

The accompanying record of the last great air raid over London furnishes an extreme illustration of this tell-tale electrical method of emotion study, and illustrates how impossible it is to supress these phenomena : for the patient preserved a very calm exterior throughout the ordeal.

But the matter goes considerably farther than has been suggested so far. Professor Waller found that his subjects reacted to his stimuli in varying degrees ; and the same subject reacted differently at different times of the day and in different states of health. In other words, this electrical reaction was a means of measuring not only emotional effect,



A.M.W.—Emotive response to the Air raid of May 19-20.
M. First warning by maroons.
G. Commencement of Gunfire, etc.
H. Aeroplane hum very audible.
S. Second warning signal by siren

FIG. 15.

but also bodily condition—it indicated that bodily condition alters appreciably with work done and with the onset of fatigue.

This view led to the employment of a device whereby the amount of "work" done by a man could be measured in terms of the amount of expenditure of his own bodily or nervous energy. This "work" is not, of course, the same thing as output. It may be very much greater, since the

man may be expending useless efforts in combating the effects of noise and stress.

Professor Waller took a dock labourer, and observed him from hour to hour, noting the amount of carbonic acid gas being breathed out—this giving, in his view, an index of the energy being used up. He found that the labourer, who was doing time-work, breathed out during the first hour or so 5 cubic centimetres of carbonic acid gas per second. Later in the morning he was, however, breathing out 10 c.c., and later still 15 and 20 c.c. This increase of the gas breathed out indicated the onset of fatigue, for it was abolished after the dinner-hour, to make its appearance again during the afternoon. Thus the expenditure of energy became greater for the man as he became more fatigued, and his electrical phenomena altered accordingly. Over the whole day the amount of carbonic acid gas breathed out per second averaged out at 14.

Later, a piece-worker was subjected to the same test. He was also an experienced worker, a member of a gang of six men who were paid so much for so many tons of coal handled. The gang shared profits and consequently exercised a certain measure of control over one another. Any member who showed signs of weakness or slackness was unlikely to be tolerated for any length of time by his companions. In the circumstances the work done by an individual member could be taken as maximal.

The results showed that the piece-worker's output of carbonic acid gas rose more rapidly than the time-worker's, going up to 25 cubic centimetres per

second before dinner and above 30 c.c. after that meal. The average for the day was 21 c.c. per second as against the time-worker's 14 c.c. per second average. In other words, the physiological cost of piece-work to the worker and of time-work to the worker are in the relationship of 3 to 2.

Figures 16 and 17 show this graphically. The

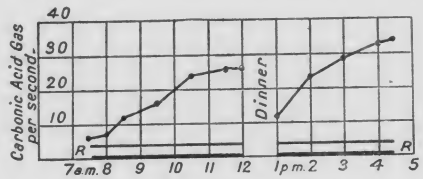


FIG. 16.—Piece-Worker.

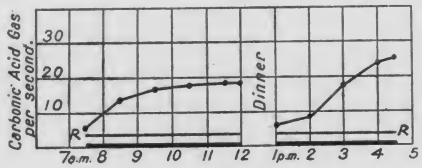


FIG. 17.—Time-Worker.

point for the employer is that the mental circumstances of the two kinds of work determine its intensity and so its cost to the employee. The man with the incentive spends more of his energy—reacts more.

This is of course an excellent thing where the circumstance makes for productive labour. It is the opposite where the circumstance absorbs energy

unproductively—*e.g.* noise. Professor Waller was able to exaggerate at will the phenomena of energy being spent—the electrical reaction—by bringing certain outside factors to bear on his subjects. He says :

> One can record by apparatus and register by photography the effect of the receipt of an agreeable letter and the effect, in exact contrast, of a disagreeable one. One can say for example that one letter is 20,000 ohms more disagreeable than another. One can in effect measure in units of resistance, in ohms, the character, whether more or less disagreeable, of any piece of news. Any cause acting on the nervous system exaggerates these phenomena.

Thus the worker whose mind is troubled, who is badly fed, whose home life is uncomfortable, whose workroom is noisy, ill-lit, or overheated, can be shown to be expending himself in an exaggerated manner in meeting these adverse conditions. Giving to bad objects he has less to give to good ones.

CHAPTER XIX

INDUSTRIAL WELFARE

We have dealt with various particular aspects and with various special trades. But so far no special mention has been made of that wider and more general effort at amelioration which is known as " welfare work."

Before the war " welfare work " meant as a general rule sporadic effort by a few charitably minded employers, and this in spite of the fact that a great awakening had begun in several directions. The war, however, demanded the utmost of every man and woman employed, and it very soon became evident that welfare work, far from being a philanthropic amusement, was a most important and valuable method of keeping what has been called " the human machinery " in good running order.

The first Welfare Orders made under the Act of 1916 came into force in December 1917. One of these affected factories in which the manufacture of tin or terne plates was carried on, and demanded that protective clothing should be worn in pickling and wet processes (all persons), with simple cloak-

room for women and girls, mess-room and washing facilities (all persons), under responsible supervision. Another Order required a convenient supply of wholesome drinking water in every factory or workshop employing 25 or more workers. Another Order dealt with first aid at blast furnaces, copper mills, iron mills, foundries, and metal works. This Order was later, 1918, extended to saw mills and factories in which articles of wood are manufactured. Two Orders made early in 1918 apply to trades in which bichromate of potash or soda is used in dyeing and tanning. The measures enjoined include protective clothing, first aid, suitable accommodation for clothing put off during working hours and arrangements for drying it, simple mess-room arrangements, and washing facilities. Similar measures are required in glass bottle or pressed glass manufacture. A final Order demanded facilities for sitting for women in certain munition works.

These measures have had a definite effect in arousing the workers to a new interest in their own well-being and in causing employers to perceive that welfare arrangements may greatly help to foster good relations in industry. The result has been that further improvements have been discussed. Miss A. M. Anderson, principal lady inspector of factories, has suggested recently the importance of welfare supervision of workers, the setting up of canteens, and the provision for preparing as well as heating food.

The Orders above enumerated have been observed in most instances in a satisfactory manner. Even

small firms, usually slow in these matters, have made attempts in certain cases to go beyond the requirements of the law. On the other hand, in the small clothing factories and workshops, largely occupied by Jews, in great centres, such as Leeds and East London, there is a far lower standard of personal welfare than in the great clothing factories. It has been suggested that in these small factories and workrooms occupiers should be grouped as regards responsibility for mess-rooms and cloak-rooms under a common provision for superintendence and maintenance.

Some of the large firms are very keenly alive to the advantages of doing all they can in this direction. For example, boys' clubs have been started in some of the most progressive works, which afford facilities for physical culture and for ambulance classes. In some instances supervisors are engaged for this work, and these

> visit men and boys who are ill, consult with them as to difficulties in their work, and bring any grievance to the notice of the management, obtaining lighter work for boys who are too weak for their assigned tasks. . . . Some of the supervisors engage all boy labour, and others are responsible for securing compliance with certain requirements of the Act, *e.g.* hours of work and certificates of fitness.

In a large factory in the Midlands conciliation boards have been formed to deal with disputes as soon as they arise. The result is said to be "absence of any labour trouble in the factory."

In certain instances it appears that the workers

are coming to regard welfare conditions as a kind of test of employers. Advertisements of good conditions are now used when seeking workpeople, in addition to promises of good wages and permanent work. Yet many industries are behind. One inspector commented on the good effect produced when 1300 cotton operatives were recruited for a large, well-found munition factory in a district where women had been found "taking their meals while sitting on the floor of a gassing room and apparently liking it."

A West London inspector calls attention to the difficulties experienced in certain of the great London stores and shops. Most of the firms are doing what they can, and new buildings projected include, as a rule, canteens, recreation-rooms, and rest-rooms. Unfortunately in certain houses changes are not easy. For example:

> The present system consists of each section being in charge of a fitter, who is an autocrat in her own department and brooks no interference. The state of the rooms therefore varies according to the temperament of the fitter—being clean if she has theories on the subject of cleanliness, but not otherwise; warm if she likes heat, and so on. She engages her own workers, so that it is difficult for the firm to ascertain whether, for example, certificates of fitness are being obtained, or if the young persons are attending school regularly. The general arrangements as to cleaning and upkeep of mess-rooms, passages, lavatories, sanitary accommodation, etc., are in the hands of charwomen and cooks, and are not under any one person's definite supervision, unless it be the workroom manager, who is content so long as she receives no direct complaints. The result is that the mess-rooms are gloomy, dingy apartments, and the sanitary and lavatory arrangements are old-fashioned and only fairly well kept.

These troubles, it is contended, would be remedied by the appointment of an experienced welfare worker. It would benefit the employers to make this appointment, more especially when other employers are even going to the length of fitting up tennis courts, taking houses on the coast to which sick and seedy workpeople may go for rest and change of air, and supplying small gardens and allotments.

The most essential welfare arrangements may be said to be, first, a good supply of clean drinking water; second, arrangements for food; thirdly, protective clothing; fourthly, facilities for personal hygiene; fifthly, seating accommodation; and finally, supervision. Drinking water must be laid on in such a manner that it can be reached easily. Strong arguments have been advanced in favour of what is called the upward jet system by which the worker drinks the water as it rises up to him. The value of this installation is that in many trades cups cannot be kept clean, for instance, oil refining, grease extraction, fish manure making, and so on. This consideration also holds good in hot and dusty trades. The water supply should not be out in the open in trades in which the workers have to support a hot atmosphere—*e.g.* the cotton industry. The change from the warm factory to the chill air is a direct incitement to respiratory and other diseases.

Common drinking-cups are open to objection also on the ground of danger of the spread of disease.

Canteens undoubtedly helped the munition workers to achieve their great and sustained labours. The workers generally do not care to go out to meals, and often find difficulty in obtaining the kind of food they require. Thus they are apt to suffer in bodily strength to the great detriment of themselves and their work. The mess-rooms need not be very elaborate, but they must be clean. At an old wooden mill in the country outside Bradford a very successful room was set up as follows :

> An old low mending room with the use of lots of white enamel paint and addition of extra windows has been made into a most excellent canteen, with a kitchen for light refreshments at one end and small rest-rooms for men and women at the far end. The dinners are sent down daily ready cooked in vacuum containers from the main works, and are said to arrive in excellent condition and very hot. All the 140 workers take breakfast in the canteen, which is fully equipped, and quite 50 take porridge every morning; 130 stay to dinner, a very large proportion taking the full dinner. Tea is taken round to the workers during the afternoon. Washing accommodation with hot water laid on is now (in 1919) being installed in the factory, and numbered pegs for clothing for each worker.

Protective clothing came into use very widely during the war, when, perhaps, 100,000 women and girls used it continuously. It is compulsory, as has been stated, in certain industries. It is desirable in almost all, not only because of the comfort it confers, but also to keep out dust. Proper facilities for washing are equally desirable, though no order as yet governs this matter. Where chemicals are being handled such provision is essential. In greasy trades it may be said to belong to personal hygiene. A factory which lacks proper washing facilities is insanitary in the modern acceptation of that term. It is thus a danger to the persons employed in it and so a danger to the State. It is, however, inefficient, for good work cannot be done except in good conditions. Some employers are well aware of this, and in one factory no fewer than six bath-rooms with cubicles attached have been fitted up.

With ambulance and first aid we have already dealt at length. But the value of rest-rooms requires to be insisted upon. Young workers are apt to feel faint at times or to suffer from minor ailments, and if they can retire for a few minutes their health is greatly benefited. The momentary rest relaxes the muscles and clears the brain and enables the man or woman to "carry on" in better vigour. The same considerations apply to the provision of seats. Before this was done in munition factories many hardships were experienced. The Order came as a great relief, and the results fully justified it. The seats are to be used occasionally and not necessarily to work on, yet there has often existed a prejudice against them, more especially in the minds of foremen.

Supervision is of extreme importance, and here there can be no doubt that training and experience are necessary. A properly qualified welfare worker

is indeed a good investment for any firm, more especially if women are employed, for such an official stands outside the organization of the business, is impartial, and possesses special knowledge. Access is easy to the management, and complaints can be ventilated at once and redressed without delay.

The welfare movement is still in its infancy, but it is a lusty infant. With its progress is bound up in no small degree the future of industry in this country. For it is in essence the recognition of the rights of employees to the full enjoyment not only of leisure, but also of work. The most far-seeing employers recognize this very clearly. Their influence is gradually extending to those who are not capable of long views.

CHAPTER XX

FOOD OF THE WORKER

THE question of food in industry is one of the oldest in the world, but only in recent years has it received the scientific consideration which is necessary to lift it from mere speculation to exact knowledge. The result is that it is now as certain as anything can be that productive output, "in regard to quality, amount, and speed," is largely dependent upon the physical efficiency and health of the worker. These, in their turn, depend on nutrition, for food energy is spent not only in maintaining the tissues of the body and its heat, but also in doing work.

This is so evidently true that it is difficult to understand why it has ever been disputed. The reason is probably that a certain type of employer worked on the principle that underfeeding or improper feeding of his workfolk was really no concern of his. They were free to act as they pleased; if they became unfit for work he could replace them by other workers.

Moreover, though they did not suspect it, these bad employers were robbing themselves by their

very greed. Recent work of great care has shown that no amount of driving will extract good work from ill-paid labourers, whose food is necessarily reduced to a minimum. These men are unprofitable servants while at work, and more unprofitable still when they break down and become a burden on the community—including their employer.

This the underfed and the improperly fed usually do at an early date. Their lack of stamina causes them to become fatigued very easily. The fatigue soon reacts on their digestive organs, setting up dyspepsia, which interferes again with what nourishment they were formerly receiving. A vicious circle is established and the man either becomes an invalid at once or else takes to alcohol, by means of which he can perhaps whip himself to new efforts for a little time. The end is the same in either case.

What, then, is the necessary diet for the industrial worker? The question was asked—in great urgency—at the time of the pressure on munition works, and was answered generally thus: "A dietary containing a sufficient proportion and quality of nutritive material, suitably mixed, which is easily digestible, appetising, and obtainable at a reasonable cost." There are, as is well known, six essentials in any food supply: protein (which is the largest constituent of meat, eggs, milk, cheese, and is found in good quantity in oatmeal and other cereals); carbohydrate (*i.e.* the sugars and the starches, for example, potatoes and bread); fat, salt, vitamines (which are the curious and still rather mysterious living principles found in fresh food, but often absent from preserved food, without which life cannot be maintained), and water.

The vitamines deserve special mention, because their proper understanding is a thing of yesterday, and their value in warding off what are known as "deficiency diseases" is enormous. They are removed by certain processes of milling—*e.g.* in the preparation of white flour and polished white rice. They are destroyed, too, by prolonged cooking, and are absent from foods preserved in tins. They are present in butter, dripping, and margarine when made from beef fat, but absent when it is made from vegetable fat. The potato contains them in sufficient quantity and makes an excellent food with bread and tinned stuffs.

The type of diet required varies with the kind of work being accomplished. Thus hard labour which wears and tears the tissues demands a diet rich in substances capable of being used to repair waste—*e.g.* meat, cheese, eggs, and so on. In cold weather work fat is valuable because of the large amount of energy, heat for example, which it liberates. Fortunately the cheaper kinds of food, bread, margarine, porridge, milk, herrings, cheese, beans, onions, cabbages, swedes, and the cheapest cuts of meat provide all the requisite nourishment.

It is quite certain that many workers are to-day getting a dietary which is not really effective. The reason for this is partly economic, but probably the fact that food has to be eaten away from home and in unfavourable surroundings in many cases is one

of the chief causes of the evil. The worker who is so situated either brings food with him already cooked and ready for eating or brings food which he can cook himself at the factory. Alternatively he goes to a local eating-house and takes his chance of a meal there. The objection to the first course is that a limitation is set on the kinds of food which may be cooked beforehand and eaten cold, and these are often unsuitable and but poorly nourishing. Moreover, when the weather is warm or the food is kept for any length of time in a hot workshop it degenerates.

Again, warmed-up food is generally not so nourishing as freshly cooked food, and unless the facilities are ample it is often difficult for all the employees to prepare their meals efficiently. Undercooking is apt to result, with consequent digestive and other troubles. The meals served in local eating-houses are often inferior, and give rise to troubles of the same kind.

Now it is manifestly a great danger to industry that its workers should be compelled to struggle against discomfort and hardship in obtaining the very sources of their power; and if, in addition, these sources are vitiated and disease set up the loss becomes a matter of profound anxiety.

It was for these reasons that the Ministry of Munitions set itself the problem "to supply suitable food at a low price for large numbers of persons at specified times," and solved it by the industrial canteen. The problem exists to-day in every great, and in most small, industrial concerns, and its solution is not less pressing now, in times of peace, than it was in times of war.

We have already described how the most progressive firms are handling this matter. As, however, many firms have still to establish canteens, it may be useful to indicate the essentials of a successful undertaking.

In the first place the site must be suitable. It should, above all things, be pleasant, for the effect on the mind of a dingy outlook, or a room hemmed in by buildings, is notoriously bad. There can be no sense of release and comfort, both important aids to digestion. The site, too, should be chosen in close proximity to electric, gas, and water mains, and be capable of easy and efficient drainage. It should on no account be at a great distance from the works.

Of course, if all the workers can go home for meals the scheme will be a much less ambitious one than will be the case where meals must be provided. A buffet-bar in these circumstances will meet requirements. If, on the contrary, workers need their meals on the premises a definitely planned canteen will be necessary. The plan (Fig. 18) is drawn from that suggested by the General Health of Munition Workers Committee (Mr. D. N. Dyke, A.R.I.B.A., H.M. Office of Works). It affords accommodation for 100 diners. Plans have also been prepared for 500 diners.

It is suggested that if the tables are made of good-quality wood no coverings should be used; though a covering does improve the appearance of

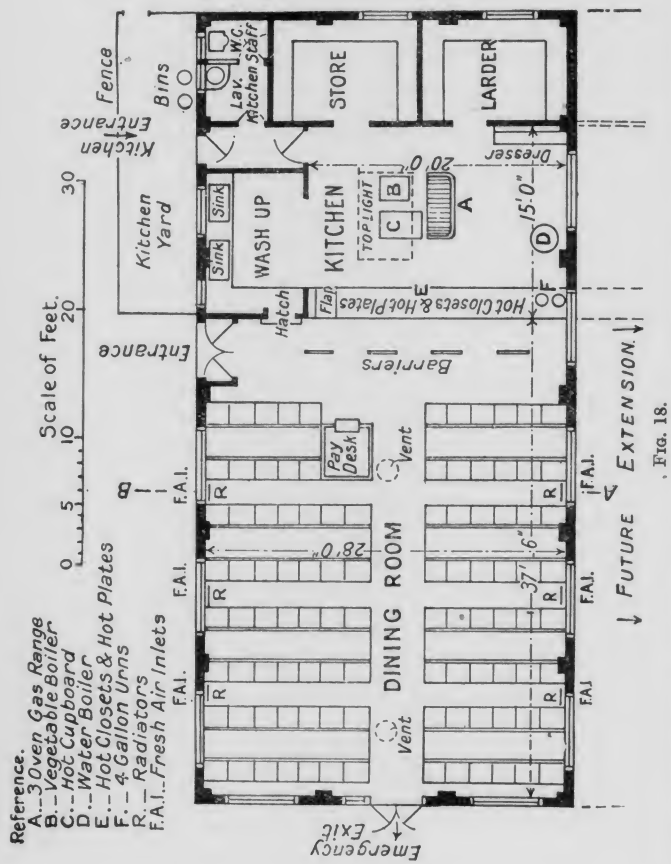


Fig. 18.

the tables. Chairs are recommended in preference to forms, as they are more comfortable. Waste-paper baskets should be provided in order to secure tidiness. Rustless knife blades are also an advantage. Tea urns with earthenware linings are strongly recommended.

The floors have to stand a good deal of wear and tear, and should be of concrete finished with a granolithic face. Short barriers in front of the counters are advisable.

CHAPTER XXI

NATIONAL PHYSICAL EDUCATION

THE excellent effects of the physical training which so large a portion of the community received during the war have opened the eyes of all to the advantages which may be gained by care of the body. It is no exaggeration to say that this training rescued a large number of men from comparative decrepitude and saved an equally large number of boys from degenerating into ill-health. The effects are still evident, and the industry of the country is reaping advantage from them.

It is for this reason that an influential body of men, including some of the most distinguished physicians and surgeons of the day, have launched a movement for national physical education. These reformers perceive that, in present circumstances, the hope of industry lies in health. Working hours are short, leisure hours proportionately longer; if the work is to be done it must be in the hands of men and women who are fully capable in mind and body.

Moreover, there is great need in this time for

"the spirit of the game," the higher mental outlook which comes to the man, be he master or employee, who has devoted himself to the organized forms of exercise and learned the lesson of "playing for his side."

The subject was dealt with recently at considerable length by Surgeon-Commander Digby Bell, R.N., who lectured upon it before the Royal Society of Medicine, and gave it as his considered opinion that physical education is the very foundation of preventive medicine. This doctor served in the flagships of Sir John Jellicoe and Sir David Beatty and was in addition adviser in physical training to the Commander-in-Chief.

His description of life in the Navy during the war, of its effects on the men, and of the part played by recreation in improving matters, deserves to be read and considered by every doctor and employer of labour. For though conditions ashore, in workshop and factory, are much less severe, yet there exists here also a monotony detrimental to human activity in the best sense of that term; and so, by universal consent, detrimental also to work and to output. We quote Commander Bell's own words:

> Up North in the Grand Fleet the spectre we had to consider seriously was the possible onset of a depression due to the incessant nervous strain and the ghastly monotony. . . . Picture living in a home in which you can never get away by yourself for one moment's peace, but around you all day and night is a heaving mass of struggling humanity, huddled together in an incessant noise on electrically lit mess-decks, with the very air

you breathed pumped down to you artificially—then perhaps you can appreciate that sort of restless monotony which almost grips you by the throat. That this monotony cannot be said to have affected the morale of the sailor to any extent was due in great part to the ever-watchful care and forethought of those in charge of units and squadrons of the Grand Fleet.

The lessons learned were that recreation and more recreation, of a simple and attractive nature, for *all* on board ship was wanted. It was always possible to keep the 10 per cent who excelled at games amused and energetic. They would roller-skate, box, dance, or do anything to keep themselves fit and cheery when weather and other conditions made landing on shore impossible. But it was the 90 per cent who were not endowed with this natural ability to excel at games on whom we had to concentrate in order to kindle a small spark of energy to shake off the dull and listless mood into which they were unconsciously drifting.

The problem of the 90 per cent who are not gifted with the natural instinct for recreation is just as urgent outside the Services as it was in them. No employer of labour needs to be told of the difference between the "10 per cent man," the man who has developed in him the love of active recreation, and the "90 per cent man," the man who has no such aptitude. The one is usually alert, clear-eyed, intelligent, a leader; the other too often a mere machine, without light or enthusiasm. It is indeed true that "activity is health."

Commander Bell laid down the plan of campaign of the new movement under three headings, and

these we have reason to believe will form the basis of work:

1. Activity developed by physical training.
2. Energy developed by recreational training.
3. Character developed by moral training.

The first object is to secure continuity. The schoolboy obtains a certain physical education. But this too often stops when he leaves school. The lad goes into the world and begins work, and his leisure hours are heavy on his hands. He loses the aptitude for physical development and not infrequently becomes a "sloucher." This lad has joined the 90 per cent, and he represents on the one side a loss to industry and to the State and on the other a loss to himself. The subject is now exercising the minds of the authorities, and has been referred to in recent publications by the Ministry of Health and Board of Education.

> The overwhelming success [one of these declares] which attended the general introduction of games behind the lines in France suggests that we have made far too little use of our national aptitude and love for games in the education and training of the young and as a means of wholesome recreation for the adult.

Moreover, physical training must not only be continuous, it must be corrective. This point is of great importance, for it is now certain that all kinds of crippling disabilities can be removed or prevented or mitigated by judicious exercises—*e.g.* flat feet, weak ankles, knock knees, and so forth.

This, however, is but the fringe of the subject,

for you cannot " drill " men into good health. The difference between mere " drill " and recreation is fundamental. It is to the latter that our industries must look for the clear brains and strong muscles so necessary for their success.

The " game," indeed, is a moral as much as a physical training. Commander Bell declared :

> We must conclude that energy is dwindling because more people are willing to watch [a game] than to take part, and recreation does not attract. To put it in another way, 10 per cent wish to play and 90 per cent are content without. . . . The 90 per cent have never indulged systematically in sports and games principally because they have never had the opportunity.

The new movement then aims at bringing opportunity to those who have it not and who, being without it, cannot even value what they have lost. The medical profession is aroused ; the Government is taking action, at least in the schools—and school-days now extend, under the new Education Act, to a much later period than formerly. It remains for employers of labour and representatives of labour to join forces with these others in order that the stamp of " National " may be set upon the movement.

The recreational side of each industry would be developed along the most useful lines and in relationship to that of every other industry. Does any employer suppose that he would not personally benefit by such a system ? Let him recall the fact that some of the most successful business enterprises in the country are leading the way in this respect

and have promoted athletic clubs, laid out sport grounds, and installed swimming baths and provided instructors. Sir John Goodwin, the Director-General of the Army Medical Service, has recently referred to the wonderful changes wrought in soldiers in the convalescent depots in France. This change was produced by games and the spirit which games bring with them. That spirit is more than ever necessary to-day in our industrial world.

There is still a further aspect of the matter which is apt to be lost sight of when the larger issues are being considered. Every industry exercises in some fashion a physical effect upon those engaged in it. Either one set of muscles are developed too greatly and at the expense of other sets or one organ of the body is overtaxed. This is at the bottom of what are called " industrial deformities," and also, to some extent, is responsible for industrial diseases. The evil tendency can be continuously corrected if imagination is brought to bear on the problem. Thus the " opponent " group of muscles can be developed by suitable exercise or, better still, by games chosen because they make calls upon certain muscles. The employee in this way is able, day by day, to oppose the tendency to ill-health and to keep his fitness in spite of his occupation.

There is thus, if only we had the wit to see it, a special difficulty to be solved in each trade or calling. On the solution of it depends the working efficiency of that trade, and so, in a wider sense the working efficiency of the whole people. The professional man, for example, guards his health against a

sedentary occupation by regular recreation chosen for him, very frequently by his medical adviser. The worker must be accorded a like advantage. The industrial doctor in this country, following the example set in America, must come to the study of these needs. He must suggest the lines on which recreation ought to proceed in every branch of industry and he must superintend the carrying out of his ideas.

It is absurd to suppose that so valuable a help towards efficiency will be resented by the workers of the country. On the contrary, if the experience of the war is worth anything, it will be welcomed. Those who have first-hand knowledge of the British soldier in hospital know how eager he was to regain his health, and how ready he was to follow any advice likely to lead to this result. As a worker in industry he will not prove less grateful for guidance and opportunity.

CHAPTER XXII

AMERICA'S PROGRAMME

THE United States Public Health Service has recently published a book entitled *Studies of the Medical and Surgical Care of Industrial Workers.* Its keynote may be said to be that industrial medicine is no mere affair of employers and employed, but, in fact, concerns the whole welfare of trade and, further, of the nation. It is a branch of preventive medicine, and as such demands the close attention of Governments as well as of the medical profession. Indeed it constitutes "a compromise between the ideals of medicine and the necessities of business."

Another definition is worth quoting: industrial medicine is "the theory and practice of medicine applied to the purpose of preventing and alleviating sickness and injury among industrial workers in order that they may enjoy the benefits of continuous productive employment."

The report deals with 155 industrial establishments. These employed 20 consulting physicians, 68 whole-time physicians, 50 part-time, and 37 on

call—*i.e.* 175 physicians in all, and in addition 13 dentists were engaged. There were dispensaries at 137 of the establishments. These arrangements show very clearly that in the United States the new movement is under the control of the medical profession. In the United Kingdom this is not so, and there can be no doubt that the United Kingdom is suffering from the omission.

The American writer goes on to show in what direction and at what times the doctor ought to make his influence felt. He should be present at the beginning of the industry—*i.e.* at "industrial birth." He ought to select the workers suited to the work in hand. We have frequently urged this for our own industries, since there can be no greater economic calamity than that which follows the employment of the physically unsuitable. Moreover, at present in order to maintain a personnel of 1000 it is usual to engage 1000 new workers annually. Mr. Selby quotes one company which in the year 1917 had a labour turnover of "somewhat over 400 per cent." Every engagement represented a cost of about £1. It is easy to see, therefore, that careful selection will rapidly repay itself and increase the output of the industrial undertaking. Nor need this selection in any way militate against the interests of the employees, for no man desires to lose his health, and there are few men whose health will prevent them from engaging in all forms of industry. When the right kind of work has been found the man may devote himself to it in the comfortable knowledge that he is not thereby

lowering his working capacity—his most valuable asset.

Again, the American movement recognizes the need for the doctor all the way through industrial life. He must constantly supervise the health of the workpeople, and the surroundings in which they labour must be his especial care. We have already dealt with many aspects of this question, and have urged the necessity for those very measures which the United States has seen to be so essential and which she is busy carrying into effect—*i.e.* medical attention to personal ailments, tours of inspection of drainage and water supply, of lighting and heating and ventilation, instruction in personal (including dental) hygiene, and the like. As we have pointed out, some progress has been made in this country along these lines, but until the doctors bestir themselves and recognize their high calling this can only be desultory.

Finally, the doctor is required to save the industrial worker when his health threatens to break down or when it has broken down. This may take the form of "out-patient treatment," or it may take the form of visiting the sick in their homes. Then when the worker has recovered to some extent "after-care" must be used so that he may be restored to full working capacity.

This subject of after-care is a very big one. Possibly here the United Kingdom is not so far behind the United States as in other aspects of the industrial medical movement, for the war has taught us sharp lessons which we have learned almost in

spite of ourselves. The Army could not afford to lose its human machinery, and so the orthopædic surgeon was called in to make the best of each injured man, and what were called "curative workshops" were evolved. In this a man obtained the necessary medical training of stiff joints and muscles while at the same time carrying on an occupation—*e.g.* turning a lathe. The Ministry of Pensions is carrying on the good work. Another aspect of the question, "medical orthopædics," was discussed and described in connexion with a plea for the after-treatment of tuberculous patients in village colonies. It was urged that, when a man has recovered from the acute stage of his tubercular disease, he should not be sent back to his old occupation to relapse in a bad environment and infect others with his disease, but should be afforded the chance of suitable work in open-air surroundings, at least until his lungs became sound again.

A beginning has been made with this aspect of after-care work, and there seems to be little doubt that the movement will spread rapidly. The industrial doctor will then be expected to decide as to whether or not a given employee who has been stricken down with illness is likely to be able to come back to his old post, or requires to take up a different type of work. Our American writer, in showing how much need there is for work of this kind, recounts the case of two blind men found in the plant of a large electric motor company, and of 51 crippled employees at the factory of an Ohio shoe company.

The report goes on to lay it down that "an establishment employing anywhere from 200 to 500 people is warranted in having a dispensary; that such an establishment is justified in having either a whole-time or part-time physician; and that, if he be on a part-time basis, his services may advantageously be augmented by a trained female nurse or a person who has been taught to handle the routine work under his direction." Where 500 to 1000 persons are employed, the part-time services of a dentist ought to be retained.

Attention is especially drawn to the need for physicians trained in industrial hygiene, a need which is very great in this country at the present hour. Those who drift into the work are said to "drift with it," while those who act as "finger-wrappers" for the money it brings them are nothing but a reproach to the science. What is wanted are men "giving their brains and hearts to industry, striving at all times to better conditions among the working people and to benefit industry itself." The doctor himself is urged to "organize, deputize, and supervise." The report contains most admirable plans and drawings showing how dispensaries and medical quarters should be built.

The following summary is given, and this is quoted in full to show how seriously the Government of the United States regards this branch of science and how wide is the scope given:

1. Treatment of injuries in dispensary, home, or hospital by physician, attendant, or consultant, in-

cluding orthopædic and reconstructive surgery when necessary.

2. Opinions as to disabilities from injury and recommendations as to compensation awards.

3. Rehabilitation of impaired workers.

4. Consultation and service, including dental, for the alleviation of ailments that become evident during hours of employment.

5. Assistance in obtaining skilled medical, dental, and nursing attentions when employees themselves are unable to procure them.

6. Visits on sick absentees to assist in treatments, to render social aid, or to instruct.

7. Regular factory inspection designed to uncover conditions that are inimical to health, and written recommendations to proper officials for their correction.

8. Studies of the effects of methods, processes, and machinery operations upon health and body functions, relating to posture, eye-strain, monotony, speed, poisons, etc. Written recommendations to proper officials when effects are found to be harmful and advice to employees which will enable them to minimize the harmful results of processes from which hazards cannot wholly be removed.

9. Physical examinations of applicants for employment and written recommendations to employing officers relative to applicants' fitness for work.

10. Examinations of applicants for re-employment when the periods of absence warrant them.

11. Examinations of employees when their shop efficiency falls off, unless the reasons are evidently not physical; advice and treatment or aid in obtaining treatment to such as need it; and written recommendations to foremen when deemed wise.

12. Examinations of employees returning to work after sickness or injury and written recommendations to employing officers and foremen if employees are not fully restored.

13. Examination of employees who do not feel well or do not appear well to their foremen or fellows: advice to employees when it is indicated and written recommendations to foremen if altered working conditions are essential.

14. Examinations of workmen ceasing employment after having been exposed to special health hazards and explicit records of their conditions.

15. Frequent examinations to follow up previous findings.

16. Monthly examinations of all process workers, those who may be engaged in any work that may in any way have ill effects, and of food handlers.

17. Epidemiological service, including intimate cooperation with municipal health authorities.

18. Health instruction by personal talks in the homes or factory, by lectures, posters, or pamphlets.

19. Records of data that will assist in the prevention of accidents and sickness.

20. Records of facts that will enable employers and employees to obtain equitable compensation adjustments.

21. Records of information that will show the scope and value of all medical activities.

22. Studies of facts and data with the view to developing scientific knowledge and usefulness.

23. Contributions to scientific and trade publications.

24. Attendance at meetings of scientific societies.

25. Constant efforts to merit and retain the confidence of the employees and the approbation of the employers.

26. Frequent conferences with those in authority.

27. Co-operation with other establishments and local State and national health authorities.

28. And, finally, the admonition to organize, deputize, and supervise.

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